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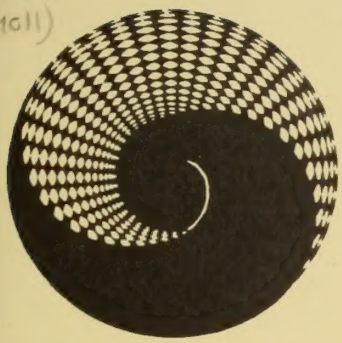

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Description of a new species of *Chicoreus (Triplex)* from the Philippine Islands.

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KEYWORDS: Gastropoda, Muricidae, new species, Philippine Islands.

ABSTRACT. *Chicoreus (Triplex) dodongi* n. sp. is named from Samar, in the Philippine Islands. It is compared with *C. (T.) strigatus* (Reeve, 1849), *C. (T.) akritos* Radwin & D'Attilio, 1976, and with young specimens of *C. (T.) torrefactus* (Sowerby, 1841) and *C. (T.) saulii* (Sowerby, 1834).

RESUME. *Chicoreus (Triplex) dodongi* n. sp. est décrit à partir de 7 exemplaires provenant de l'Ile de Samar, aux Philippines. La nouvelle espèce est comparée à *C. (T.) strigatus* (Reeve, 1849), à *C. (T.) akritos* Radwin & D'Attilio, 1976 et à de jeunes *C. (T.) torrefactus* (Sowerby, 1841) et *C. (T.) saulii* (Sowerby, 1834).

INTRODUCTION

The subgenus *Triplex* Perry, 1810 was recognized by HOUART (1992) to include 39 Recent species from the Indo-West Pacific, a large number of which named after 1976.

New dredging methods, recent scientific expeditions, and a better knowledge of the habitat, have largely contributed to the discovery of these new species and of new material.

Abbreviations: MNHN: Muséum National d'Histoire Naturelle, Paris. NMNZ: Museum of New Zealand, Wellington. NM: Natal Museum, Pietermaritzburg.

SYSTEMATICS

Genus *Chicoreus* Montfort, 1810
Subgenus *Triplex* Perry, 1810

Type species, by monotypy: *Triplex foliatus* Perry, 1810 (= *Murex palmarosae* Lamarck, 1822).

Chicoreus (Triplex) dodongi n. sp.

Figs 1-4

Material Examined. Holotype, 22.40 mm, MNHN, 1 paratype, 18.36 mm, NM L1 590/T1295, 1 paratype, 20.46 mm, NMNZ m. 269002, 4 paratypes, 26.60 mm, 23.35 mm, 20.28 mm, and 18.42 mm, coll. R. Houart.

Type Locality. Philippine Islands, Samar, 2-10 m, November 1994.

Description. Shell small for the subgenus, up to 26.60 mm in length at maturity. Spire high with 3.25 protoconch whorls, and up to 6.5 weakly spinose teleoconch whorls.

Suture weakly impressed. Protoconch small, whorls rounded, smooth, glossy; last whorl with a weak, single keel abapically; terminal varix unknown (eroded) (Fig. 4).

Axial sculpture of teleoconch whorls consisting of high, strong, rounded, varices, each with short, frondose spines, and of high, rounded ribs between each pair of varices. First whorl with 9 or 10 axial ribs; second to last whorl with 3 varices and 2 intervaricial nodose ridges. Varices of last whorl with 5 short, open, frondose spines. Spiral sculpture of squamous, primary and secondary cords, and threads. First whorl with 3 primary cords; second whorl with 3 primary cords, 1 thread between each pair of cords, shoulder with 1 secondary cord; third whorl with 3 primary cords, 1 or 2 threads between cords, shoulder with 1 secondary cord and 2 threads; fourth whorl with 3 primary cords, 2 or 3 threads, shoulder with 1 secondary cord and 2 or 3 threads; fifth whorl with 3 primary cords, numerous threads between each pair of cords, shoulder with 1 or 2 secondary cords and 3 or 4 threads; last whorl with 5 primary cords, numerous threads between each pair of cords, shoulder with 1 or 2 secondary cords and numerous threads.

Aperture roundly-ovate. Columellar lip with 1 or 2 abapical knobs near edge, and 1 or 2 elongate knobs adapically, occasionally smooth. Edge adherent, weakly detached abapically. Anal notch broad, moderately deep. Outer lip

erect, crenulate, with 6 high, slightly elongate denticles within. Siphonal canal moderately short, narrow, straight, open, with 2 short, frondose spines.

Protoconch yellowish or pink. Teleoconch whorls creamy-white, light tan, yellow-tan, or light pink, with dark brown or blackish-brown spiral cords, axial knobs, and occasionally spiral threads. Varicial spines light orange or pinkish. Aperture white, occasionally with pinkish blotches on columellar lip and outer edge.

Operculum and radula unknown.

Remarks. At first sight, *Chicoreus dodongi* n. sp. seems similar to *C. strigatus* (Reeve, 1849), but it primarly differs in the different protoconchs, consisting of 3.25 whorls in *C. dodongi*, while of 2 whorls in *C. strigatus*. *C. dodongi* also has fewer intervaricial ridges, and fewer primary spiral cords than *C. strigatus*. It has 5 frondose spines on the varices of last whorl instead of 6 in *C. strigatus*. The denticles within the outer edge of the aperture are shorter, and less numerous, the anal notch is broader, and the siphonal canal is relatively shorter with fewer spines than in *C. strigatus*. *C. akritos* Radwin & D'Attilio, 1976, a form of *C. microphyllus* (Lamarck, 1822) (HOUART, 1992: 59) has a similar protoconch, but *C. dodongi* has a relatively smaller shell with fewer frondose spines than *C. akritos*, no spinelets on the varices of last whorl, fewer spines on the siphonal canal, a twice broader anal notch, and the outer apertural lip with 6 denticles instead of 10-12 lirae in *C. akritos*. Young specimens of *C. torrefactus* (Sowerby, 1841) and *C. saulii* (Sowerby, 1834) are somewhat similar, but different protoconchs, different spiral sculpture, and shorter, less numerous denticles within the outer edge of the aperture, differentiate *C. dodongi* from both species. *Chicoreus dodongi* n. sp. was collected alive, and is only known from a very limited number of specimens.

Etymology. Named for Mr. Erwin Espinosa, a.k.a. "Dodong" (Philippines) who collected the specimens.

Acknowledgements

I am very grateful to Jean-Pierre BARBIER (France) who provided the specimens. His continuous collaboration is most useful, and always very appreciated.

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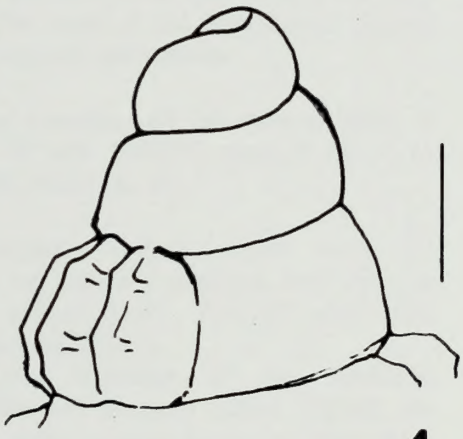

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FIGURES

1-2. *Chicoreus dodongi* n. sp., Samar, Philippine Islands. Holotype MNHN, length: 22.40 mm.
3. *Chicoreus dodongi* n. sp. Samar, Philippine Islands. Paratype coll. Houart, length: 26.60 mm (canal slightly broken).
4. Protoconch of *Chicoreus dodongi* n. sp. (scale bar: 0.5 mm).

Tornus tornaticus, a new species from Mauritania, West Africa (Gastropoda; Tornidae)

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KEYWORDS: Mollusca, Tornidae, *Tornus*, East Atlantic, Mauritania, Recent, taxonomy.

ABSTRACT. Recent investigations off the coast of Mauritania, initiated by the Netherlands Institute for Sea Research, have revealed a new species *Tornus tornaticus*. The assigment to *Tornus* and even the family Tornidae is provisional.

INTRODUCTION

In May and June 1988, investigations by the Netherlands Institute for Sea Research (NIOZ, Texel) and the Delta Institute (Yerseke, now Nederlands Instituut voor Oecologisch Onderzoek) using the research vessel "Tyro" in the Banc d'Arguin [Tyro Mauritania I Expedition], have revealed sediment samples in which we encountered many known and unknown gastropods. Amongst them a small and remarkable, rather skeneimorph gastropod species.

Several planispiral and/or skeneimorph genera of marine molluscs, belonging to families like Trochidae, Tornidae, Vitrinellidae, Vanikoridae were discussed by ADAM & KNUDSEN (1969). They already noticed that the generic division of these micromolluscs was far from convenient and, awaiting anatomical research, they did not provide the family rank of these taxa.

The new species from off Mauritania could not be identified using ADAM & KNUDSEN (1969) and a search in other literature could not solve the identification. Our first impression was that it could be a species of an undescribed genus but having only dead collected shells we provisionally assigned them to the genus *Tornus*.

SYSTEMATICS

Tornus tornaticus n. sp.

Figs 1-3.

Description of the Holotype (ZMA Moll. no. 3.94.017): Shell small, with numerous axial growth lines and with a strong basal carina. Width 1.59 mm, height 1.4 mm (fig. 1), white, translucent.

Protoconch 2.5 whorls, smooth with a hardly visible demarcation between protoconch and teleoconch. Teleoconch with strong axial growth lines and a few restored shell-damages, and with 1.3 rapidly increasing whorls. At the base of the body whorl, a strong carina is visible. Growthlines on the teleoconch are strongly prosocline and somewhat bent on the periphery. Under high magnification, very fine spiral threads are visible. The borderline of the umbilicus and the base of the shell is sharply keeled. The aperture is rectangular with one strong posterior notch and diagonally a strong anterior notch. The outerlip is thin and there is no sign of a varix. Umbilicus deep, nearly circular, about 20 % of the width of the body whorl. The inside of the umbilicus is covered with strong axial growthlines.

Type Locality. off Mauritania, Banc d' Arguin, 19°34'N: 16°55'W, depth 53-64 m; 13 May 1988; NIOZ Sta. B1.

Paratypes Studied. Apart from the holotype we studied 6 paratypes from the type sample (ZMA Moll. 3.94.018 and coll. Hoenselaar no. 18765).

In the collection of the Nationaal Natuurhistorisch Museum Leiden (NNM), we found 6 shells collected during the Mauritania II Expedition (5-21 June 1988), Sta. MAUR. 087, depth 65 m also from the Banc d'Arguin. These 6 shells are considered paratypes.

Etymology. The topside of the shell looks like a Natica and the base resembles that of *Tornus subcarinatus* (Montagu, 1803). A compilation of both words results in the name tornaticus.

Other Material Studied. Tyro Mauritania I Expedition material in ZMA):

Sta. B 2: 19°33'N-17°W, depth 99-152 m, 1 shell.

Sta. B 5: 19°57'N-17°28'W, depth 85-154 m, 3 shells.

Sta. B 7: 20°N-17°26W, depth 50-62 m, 3 shells.

Mauritania II Expedition (material in NNM and coll. Hoenselaar):

Sta. MAU. 031: 18°48'N-16°28'W, depth 70 m, 1 shell.

Sta. MAU. 034: 18°46'N-16°40'W, depth 167 m, 2 shells.

Sta. MAU. 035: 18°45'N-16°42'W, depth 200 m, 4 shells.

Sta. MAU. 085: 19°35'N-16°51'W, depth 35 m, 1 shell.

Variability. Only dead collected shells were available for study so the soft parts, periostracum and operculum are unknown to us. The species is rather uniform. The width of full grown specimens varies from 1.35 to 1.80 mm. Also the distinctness of the growthlines can vary a little.

Discussion. We have doubts about the right generic and family classification, but as long as no information of the soft parts is available, we consider the species provisionally belonging to genus *Tornus* in the family Tornidae. Maybe *Tornus garrawayi* Adam & Knudsen, 1969 from Liberia is related with *T. tornaticus* n. sp. However, that species is flatter with a less bulbous body whorl, a wider umbilicus and axial sculpture on the upper part of the whorls. *Tornus subcarinatus* from Europe and West Africa differs by its axial and spiral sculpture. Also *Conjectura glabella* (Murdoch, 1908) from New Zealand as figured by POWELL (1979: pl. 20 fig. 20) shows affinity but has two strong sharp keels bordering the umbilicus.

Acknowledgments.

We wish to thank the staff members of the Netherlands Institute for Sea Research (E.M. Berghuis, A. Kok and P.A.W.J. de Wilde) and the Delta Instituut (P.H. Nienhuis) for donating this material to the Zoölogisch Museum Amsterdam. Material from the NNM was kindly made available for study due to J. Goud, R. Vroom and E. Gittenberger. Two anonymous reviewers gave valuable comments concerning the manuscript.

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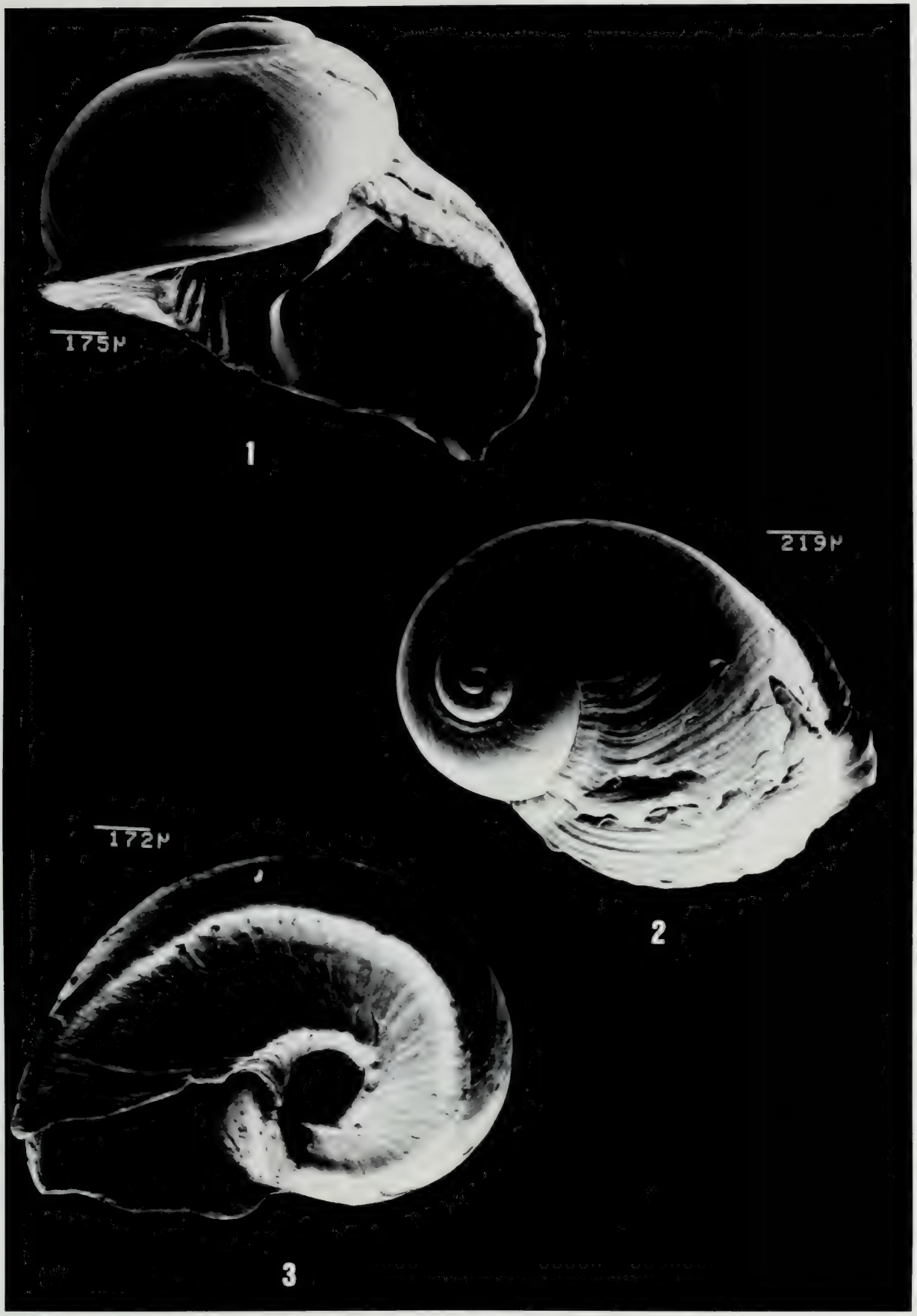

Figs 1-3. *Tornus tornaticus* n. sp.
Fig. 1. Ventral view of holotype, width 1.59 mm (ZMA Moll. 3.94.017).
Fig. 2 Top view of paratype, width 1.8 mm (ZMA Moll. 3.94.018a).
Fig. 3 Bottom view of paratype, width 1.5 mm (ZMA Moll. 3.94.018b).

The family Triphoridae (Mollusca, Gastropoda) in Cuba. 5. The genera *Marshallora, Mesophora, Similiphora, Eutriphora, Latitriphora, Aclophora* and other species without generic affiliation

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KEYWORDS: Triphoridae, Caribbean Sea, Cuba.

PALABRAS CLAVE: Triphoridae, Mar Caribe, Cuba.

ABSTRACT. Twelve species of the family Triphoridae are described within the genera *Marshallora* (2), *Mesophora* (2), *Similiphora* (1), *Eutriphora* (1), *Latitriphora* (1), *Aclophora* (1), and *Triphora* s.l. (4). New information is given for species that are already known. The protoconchs of all of them are figured. Three species new to science are described: *Aclophora sagei* n. sp., "*Triphora*" *osclausum* n. sp. and "*Triphora*" *martii* n. sp.

RESUMEN. Se describen 12 especies de la familia Triphoridae, pertenecientes a los géneros *Marshallora* (2), *Mesophora* (2), *Similiphora* (1), *Eutriphora* (1), *Latitriphora* (1), *Aclophora* (1), and *Triphora* s.l. (4), realizando nuevas aportaciones a las especies ya conocidas y representando las protoconchas de todas ellas. Tres nuevas especies para la ciencia son descritas: *Aclophora sagei* n. sp., "*Triphora*" *osclausum* n. sp. y "*Triphora*" *martii* n. sp.

INTRODUCTION

The present study is the latest in a series of publications that have reviewed the family Triphoridae in Cuba. Genera already studied include *Metaxia* Monterosato, 1884 (ROLÁN & FERNÁNDEZ-GARCÉS, 1993a), *Iniforis* Jousseaume, 1884 (ROLÁN & FERNÁNDEZ-GARCÉS, 1993b), *Isotriphora* (ROLÁN & ESPINOSA, 1994) and *Monophorus*, *Nototriphora*, *Cosmotriphora* and *Cheirodonta* (ROLÁN & FERNÁNDEZ-GARCÉS, 1994).

Prior to our revision, there were few published references to the Triphoridae of Cuba. Four species were mentioned by PILSBRY & AGUAYO (1933), and one of these was among the five species discussed by GARCIA & LUQUE (1986).

In the present work we describe and redescribe 12 species. The protoconchs of most of these species are figured and described for the first time, and the differences between related species are illustrated by features of the protoconch and teleoconch. Generic classification has in most cases been based on examination of the radula as well as on characteristics of the shell.

Studied material includes "specimens", referring to live-collected animal, and "shells", which have been collected empty.

Abbreviations used: AMNH: American Museum of Natural History, New York; BMNH: The Natural History Museum, London; IES: Instituto de Ecología y Sistemática, La Habana; MCZ: Museum of Comparative Zoology, Cambridge; MNCN: Museo Nacional de Historia Natural, Madrid; ZMA: Zoölogisch Museum, Amsterdam.

SYSTEMATICS

Suborder PTENOGLOSSA Gray, 1853
Superfamily TRIPHOROIDEA Gray, 1847
Family TRIPHORIDAE Gray, 1847

Genus *Marshallora* Bouchet, 1984

Type species (original designation): *Murex adversus* Montagu, 1803; Recent, Mediterranean.

Marshallora modesta (C. B. Adams, 1850)
Figs. 1, 2, 3, 4

Cerithium modestum C. B. Adams, 1850. Contribution to Conchology, 7: 117. Lectotype selected by Clench & Turner (1950, pl. 39, fig. 8).

Triphora nigrocincta. WARMKE & ABBOTT, 1961 (non C. B. Adams). Caribbean seashells, pl. 13, fig. k.

Material studied. Jamaica: Lectotype MCZ 186180. Southern Cuba: 20 specimens from less than 1 m depth, under rocks with sponges, and 10 shells from sediment at 10-20 m, Cienfuegos Bay.

Description. Shell (Figs. 1 & 2): see ADAMS (1850) and CLENCH & TURNER (1950). Originally described as "reddish black...with, on the upper whorls, two, and in the middle and lower whorls three spiral ridges, which are of equal size on the lower two-thirds of the shell." The number of whorls (including the protoconch) is usually 12-13, increasing to 14 in some shells, and ADAMS (1850) described "...whorls about fourteen,...". The following details complete the description:

Protoconch (Fig. 3) with about 4 whorls, nucleus with minute hemispheric granules, subsequent whorls with two spiral ridges crossed by numerous axial riblets.

Teleoconch at first with two spiral cords, the upper one being less pronounced on first whorl. A third cord appears in the middle of the space between the other two on the fifth or sixth whorl. Aperture pyriform, siphonal canal open and short; anal sinus is shallow.

Animal white, slightly translucent, with small white spots on foot and head. Tentacles elongate, narrow.

Operculum corneus, multispiral, yellowish, translucent.

Radula with formula 6-1-1-1-6 (Figs. 4 & 43); central tooth with 6 cusps on each side separated by a narrow space. Lateral teeth similar to central tooth, with only 5 cusps on each side. Marginal teeth very fine, elongated, curved.

Remarks. Shells from the studied material (Figs. 1 & 2) closely resemble the lectotype figured by CLENCH & TURNER (1950). It is important to consider the new information in addition to the original description of *Marshallora modesta*, for as shown below, several superficially similar species have been confused with it.

Marshallora cf. *nigrocincta*
(C. B. Adams, 1839)
Figs. 5, 6, 7

Cerithium nigrocinctum C. B. Adams, 1839. Boston Journal of Natural History 2: 286-287, pl. 4, fig. 11. Lectotype designated by CLENCH & TURNER (1950, pl. 38, fig. 11).

Material studied. Northern Cuba: 3 shells at 4 m, Comodoro, La Habana; 3 shells at 4 m, Jibacoa; 2 shells at 5 m, Baracoa. Southern Cuba: 2 shells at 2 m, Playa Girón; 3 shells at 2 m, Hotel Colony Bay, Isla de la Juventud; 12 shells between 10-25 m, Cienfuegos Bay. Bahamas: 1 shell from beach drift on Elbow Cay and 1 shell from Treasure Cove, Abaco I.

Description. Shell (Figs. 5 & 6): see CLENCH & TURNER (1950). Originally described as "blackish red, conic-cylindrical, with three revolving series of granules; the middle series.....on the whorls of the lower half....of equal size, but diminishing above, and wanting on the upper fifth; the upper row is less than the lower one ....and is wanting upon several of the first whorls".

Protoconch (Fig. 7) with a nucleus with minute granules, followed by a whorl with the same sculpture which subsequently develops into fine axial ribs; these ribs at first crossed by one spiral ridge, a second adapical ridge appears later. Ribs rectilinear on first whorl, then sigmoidal.

Remarks. The shells in our material (Figs. 5 & 6) vary slightly in size, but the larger ones correspond well with the original description and with the size mentioned by the author. On most of them we noticed that the sutural depression and the area below the upper spiral cord are darker, unlike the nodules, which are grey. The protoconch of *Triphora nigrocincta* was already been figured by THIRIOT-QUIEVREUX & SCHELTEMA (1982, figs. 1E & 1F) from an area close to the type locality. Our material has a very similar protoconch (Fig. 7).

The radula of the present Caribbean populations was figured by BANDEL (1984, fig. 86, pl. 5, figs. 2-3) and it is similar but not exactly equal to the Massachusetts *M. nigrocincta* shown by BOUCHET (1984, fig. 17).

The present species was placed in the genus *Marshallora* by BOUCHET (1984) based on its radula which is similar to that of *M. modesta*. It seems doubtful that this Caribbean species could be conspecific with *M. nigrocincta*, which was described from northern, cold waters (Massachusetts), and it was thought that an undescribed species might be represented. However, from the description, and the lectotype (MCZ 186157) examined, and protoconch of true *M. nigrocincta* (as figured by THIRIOT-QUIEVREUX & SCHELTEMA, 1982), we could find no important differences. Thus, if the species here studied is not *M. nigrocincta*, it could only be proved by comparison of soft parts from the type locality with live-collected material from the Caribbean.

Genus *Mesophora* Laseron, 1958

Type species (original designation): *Mesophora bowenensis* Laseron, 1958 (= *Triforis fusca* Dunker, 1860); Recent, Western Pacific.

Mesophora novem (Nowell-Usticke, 1969)

Figs. 8, 9, 10, 11

Triphora novem Nowell-Usticke, 1969. A supplementary list of new shells of St. Croix, p. 12, pl. 2, fig. 20.

Triphora novem. Nowell-Usticke, 1971. A supplementary listing of new shells (illustrated) to be added to the check list of the marine shells of St. Croix, p. 8, pl. 2, fig. 403.

Material studied. Virgin Islands.: 1 fragment (holotype, in AMNH 195419), St. Croix. Southern Cuba: 3 shells at 25-56 m, Cienfuegos Bay; 1 shell at 20 m, Cayo Matías.

Description. Shell (Figs. 8, 9 & 10), see NOWELL-USTICKE (1971). The original description is short but includes the following important details: "... 3 or 4 white beaded whorls, the remaining straight sided whorls are brown beaded, the upper whorls having two nodulous spirals, the lower whorls with three." The holotype (Fig. 8) is a broken shell. Study of our shells (Fig. 9 & 10) provides the following additional information for this species:

Protoconch (Fig. 11) with 3 1/2-4 whorls, apex covered by crowded hemispherical tubercles; subsequent with whorls axial ribs crossed by two spiral cords. Teleoconch of 6-11 whorls, initial spiral sculpture of two cords increasing to three near last adult whorl. Spiral cords with nodules that appear to be cut off at the level of the cord, especially the lower one. Between these two cords the tubercles are well separated, and are joined by oblique ribs. Last adult whorl with six spiral cords, the lower one lacking nodules, close to the siphonal canal. Siphonal canal, elongate curving towards dorsum, fully tubular besides aperture. Protoconch brown, follow by first 3 or 4 white whorls of the teleoconch. Elsewhere light brown, tinted with violet at suture and on the upper spiral cord, tubercles lighter, space between upper and lower cords whitish cream, base brown.

Remarks. The description of *Mesophora novem* was based on the holotype, which consists of an incomplete teleoconch, lacking the protoconch and the final adult whorls. Nevertheless, comparison of our shells (Figs. 9 & 10) with the type showed them to be identical in colour, size, and sculpture. Taking into account the above redescription, the characteristics of the species are well defined. The generic assignment is made on the basis of similarity of the following species.

Mesophora aff. *novem* (Nowell-Usticke, 1969)

Figs. 12, 13, 14, 15, 16

Material studied. Northern Cuba: 1 specimen at 2 m, Marianao Beach, La Habana. Southern Cuba: 1 shell at 20 m, Cayo Avalos; 4 shells at 25 m, Punta Tamarindo, and 11 shells and 1 specimen, Cienfuegos Bay.

Description. Shell (Fig. 12, 13 & 14) sinistral, ovoid elongated, pointed and light brown.

Protoconch (Fig. 16) with about 4 1/2 whorls. First whorl with crowded dense hemispherical granules; this sculpture later develops into axial ribs crossed by two spiral cords, the upper one being attenuated in the beginning and fading out in the middle of the last whorl.

Teleoconch with two nodulous spiral cords on early whorls. A third spiral cord forms two or three whorls before the body whorl; it is located closer to the upper cord and is initially very small, enlarging slowly until the three cords are of equal size on the body whorl. Brown on the lower part of the teleoconch is darker at the suture, with similar color extending to the edges of the upper and lower nodulous cords; the nodules themselves are of a

lighter steely color. The spaces between these spiral cords are paler, orange on beached shells. Siphonal canal short and curved full enclosed beside the aperture.

Animal cream coloured with irregular yellowish markings. Tentacles elongated. Eyes are in the base of the tentacles, with a small external prominence.

Operculum subcircular, nucleus central.

Radula (Figs. 15 & 44), with formula 12-1-1-1-12, and central tooth with three cusps, lateral teeth with four cusps, marginal teeth with three cusps of similar size.

Remarks. The generic classification is based on a combination of the radular features and the characteristic shell. The two spiral cords on the upper part of the teleoconch have nodules that are slightly flattened adapically, and are thus similar to those of *Mesophora granosa* (Pease, 1870) and *M. negrita* (Laseron, 1958), as figured by MARSHALL (1983).

The shell is superficially similar to that of *M. novem*, which, however, is a lighter, cream-violet color, with the lower spiral cord cream instead of brown. In *M. novem* the medial spiral cord does not appear until shortly before the body whorl, the axial ribs are more obliqued, and, the siphonal canal is a little longer. Comparison of the protoconchs shows an apparent difference in size of the apical tubercles (see Figs. 11 & 16), and on this species the upper spiral cord almost disappears on the first or second whorl of the protoconch. However, these observations are based on a limited amount of material, and it is uncertain whether this represents an ecological form or an undescribed species. We prefer not to give it a new name until more material can be examined.

Genus *Similiphora* Bouchet, 1984

Type species (original designation): *Triphora similior* Bouchet & Guillemot, 1978; Recent, Mediterranean and East Atlantic.

Similiphora intermedia (C. B. Adams, 1850)

Figs. 17, 18, 19

Cerithium intermedium C. B. Adams, 1850. Contribution to Conchology, 7, p. 119. Lectotype designated in Clench & Turner (1950, pl. 38, fig. 9).

Triphora pulchella (C. B. Adams, 1850) in Abbott, 1974. American seashells, p. 111, fig. 1135.

Material studied. Northern Cuba: 1 specimen and 4 shells from Marianao Beach. Southern Cuba: 15 shells in sediment from 56 m deep, Faro de Los Colorados and 20 shells in 10-20 m, Cienfuegos Bay; 2 specimens and 4 shells at 15 m, Punta Pedernales, Isla de la Juventud.

Description. Shell (Figs. 17 & 18), see ADAMS (1850) and CLENCH & TURNER (1950). The shell varies in length from 2.8 mm (with 6 teleoconch whorls) to 7.8 mm (with 11 whorls). The following additional features should be noted: The color is constant in the lower spiral cord (white) and on the upper (dark or light brown). Median spiral cord withish, cream and brown, usually remaining lighter than the upper cord.

Protoconch (Fig. 19) with 5 1/2 whorls, first whorl covered by hemispheric tubercles. Second whorl with axial threads crossed in the lower half by a spiral thread. A second spiral thread appears on subsequent whorls, reverting to a single cord on last whorl.

Animal with the head and anterior part of the foot blackish. Tentacles translucent white with black spots. The eyes at the base of the tentacles, with a nearby swelling.

Remarks. The description is clear and at present there seems to be no doubt on the identity of this species. DE JONG & COOMANS (1988) mention the confusion of some authors as to the name assigned to this species.

NOWELL-USTICKE (1971) mentions figure 9 in the plate 38 of CLENCH & TURNER (1950) as not matching the original description and he considers it to be *T. novem*. We do not agree with this opinion because that specimen shows three equal spiral cords on the fourth-fifth whorl of the teleoconch which does not occur on *T. novem* (see Figs. 8-10).

Other Caribbean banded triphorids in which the upper spiral cord is brown are *Monophorus ateralbus* Rolán & Fernández-Garcés, 1994, which is smaller and pyriform with larger nodules; *Isotriphora taenialba* Rolán & Espinosa, 1994 which has the colour cream instead of white, with a large and white, paucispiral protoconch. *"Triphora" elvirae* De Jong & Coomans, 1988, *"T". ellyae* De Jong & Coomans, 1988 and *Eutriphora bermudensis* (Bartsch, 1911) are also spirally banded but the upper spiral cord in these species is white.

"Triphora" elvirae
De Jong & Coomans, 1988
Figs. 20, 21, 22

Triphora elvirae De Jong & Coomans, 1988. Marine gastropods from Curaçao, Aruba and Bonaire, p. 50, pl. 34, fig. 240.

Material studied. Curaçao: Holotype, in the ZMA (n° 3.87.071). Southern Cuba: 3 shells at 20 m, Cienfuegos Bay.

Description. Shell (Figs 20 & 21). Additions to that of DE JONG & COOMANS (1988):

Protoconch (Fig. 22), present on only one of our shells, of 4 whorls, first whorl with minute hemispherical granules arranged in rows at apex and above suture. One spiral thread on next whorl. A second adapical spiral thread is faintly visible on the second and third whorls, being two threads of equal strength on the last whorl.

Remarks. Our shells (Fig. 21) are very similar to the holotype (Fig. 20) but this has light brown color that extends further from the spiral brown nodules.

The generic position of the present species is uncertain as the animal and radula have not yet been seen.

Compared with other Caribbean triphorids in which the upper spiral cord of the teleoconch is white *Iniforis turristhomae* (Holten, 1802) and *I. pseudothomae* Rolán & Fernández-Garcés, 1993, both have a tubular anal hole located far from the aperture. In *Eutriphora bermudensis* the shell is smaller and the brown colour extends further from the spiral nodules and the base is dark brown. In *"T". ellyae* the white colour is limited to the upper spiral cord, the rest of the teleoconch including the central cord being brown. *Cheirodonta decollata* Rolán & Fernández-Garcés, 1994 is smaller, darker, and with a brown base.

"Triphora" ellyae
De Jong & Coomans, 1988
Figs. 23, 24, 25

Triphora ellyae De Jong & Coomans, 1988. Marine gastropods from Curaçao, Aruba and Bonaire, p. 50, pl. 34, fig. 242.

Material studied. Curaçao and Aruba: Holotype, ZMA (n° 3.87.072). Northern Cuba: 3 shells at 15 m, La Habana; 2 shells at 4 m, Jibacoa. Southern Cuba: 1 shell at 56 m, Faro de Los Colorados and 3 more at 42 m, in Punta Tamarindo, both in the Cienfuegos Bay.

Description. Shell (Fig. 23 & 24). Additions to that of DE JONG & COOMANS (1988): Aperture ovoid with two extensions, one the short, open siphonal canal, the other the anal sinus which is deep but always open. The brown colour is present on the protoconch and on the lower nodulose cord of the subsequent whorls, except on the first whorl of the teleoconch where it is faintly visible. The median cord in the final whorl is always brown, only the upper cord and its nodules being white. The base is brown.

Protoconch (Fig. 25) with 4 1/2 or occasionally five whorls, the first covered with minute hemispherical granules which resolve into axial ribs that are immediately crossed by two similar, spiral cords.

Remarks. Our shells (Fig. 24) are very similar to the holotype (Fig. 23).

The generic position of this species will be known when live material can be studied.

Other Caribbean triphorids In which the upper spiral cord is white are: *"T". elvirae*, which is more slender and has a white base; *Similiphora intermedia*, which has three nodular cords that start on the early teleoconch whorls, and the cords have contrasting colours. *Eutriphora bermudensis* has the central cord white on the final whorls and the first whorl of the teleoconch is also white, with the brown colour beginning on the second whorl. Moreover, *E. bermudensis* has a more solid shell, and a rounded aperture, while the anal sinus is almost fully tubular at the apertural border. *Iniforis turristhomae* and *I. pseudothomae* have the tubular anal hole located far from the aperture and have contrasting colors on the spiral cords.

Genus *Eutriphora* Cotton & Godfrey, 1931
Type species (Original designation): *Triphora cana* Verco, 1909; Recent, southern Australia.

Eutriphora bermudensis (Bartsch, 1911)
Figs. 26, 27, 28

Triphoris bermudensis Bartsch, 1911. Proc. U. S. Nat. Museum, 41, p. 305, pl. 28 figs. 2 and 4.

Triphora turrissimilis. Nowell-Usticke, 1971. A supplementary list of new shells, p. 8, pl. II, fig. 408.

Material studied. Northern Cuba: 1 shell at 10 m, Herradura; 1 shell in 4 m, Jibacoa; 2 shells at 4 m, Baracoa. Southern Cuba: 1 shell

at 42 m, Punta Tamarindo, 1 shell at 56 m, Faro de Los Colorados and 8 shells between 10-26 m, in the middle of the bay, Cienfuegos. Bahamas: 1 specimen at 11 m, Chub Rocks, Abaco I.

Description. Shell: see BARTSCH (1911). From this original description some details of the protoconch must be cited "...the second (whorl) marked by a raised spiral thread which is a little nearer the suture than the summit. On the third whorl a second spiral thread is present between the first and the summit". The biggest specimens are 6 mm and have 10 whorls on the teleoconch.

Protoconch (Fig. 27) with 5 whorls. Apex covered with minute hemispherical granules smaller beside the suture. Two subsequent whorls with axial riblets crossed by an well-defined spiral thread and a much weaker thread above. These threads are or equel size on the fourth whorl, but the upper one is vanished on the last whorl out and the single thread becoming very prominent.

Radula (Figs. 28 & 45 from the Bahamas specimen), with the formula 13-1-1-1-13. Central tooth with three equal cusps. Lateral tooth with 5 cusps, being a little bigger the central one. Marginals 1-4, with 4 similar cusps, of which those at the center are finer and longer. Marginals 5-13 with 3 cusps being the central cusp narrow and elongate.

Remarks. The generic assignment is based on the similarity of the radula, protoconch and shell to those of *Eutriphora armillata* (Verco, 1909) as described and illustrated by MARSHALL (1983).

Some characters mentioned by BARSTCH (1911) in the original description are incorrect: the first whorl of the apex is not smooth but instead tuberculate (Fig. 27), being smooth in beached shells. According to Barstch: "...The spiral cord at the summit is white while the supra-sutural and median cords are brown", but in fact, close examination of the two original figures shows that the median cord is white, as in our material (Fig. 26).

E. bermudensis can be differentiated from other Caribbean triphorids in which the upper spiral cord is white, as follows: *Cheirodonta decollata* is smaller, darker and usually decollated. *Iniforis turristhomae* and *I. pseudothomae* have the tubular anal hole placed far from the aperture. "*T". ellyae* has smaller nodules, an ovoid aperture, the siphonal canal is open and the median spiral nodular cord is brown. "*T". elvirae* is larger and narrower, the brown spiral cord is very narrow and the base is almost totally white.

Genus *Latitriphora* Marshall, 1983

Type species (original designation): *Triphora latilirata* Verco, 1909; Recent, southern Australia.

Latitriphora albida (A. Adams, 1854)
Figs. 29, 30, 31, 32

Triphoris albidus. A. Adams, 1854 (1851). Proc. Zool. Soc. London, 19, p. 278.

Triforis (*Sychar*) *samanae*. Dall, 1889. Bulletin of the Museum of Comparative Zoölogy, 29, part II. p. 248.

Triphora samanae Dall, 1889. De Jong & Coomans, 1988, p. 51, pl. 34, fig. 245.

Material studied. Southern Cuba: 4 shells and 2 fragments from sediments between 10-25 m, Cienfuegos Bay. Bahamas: 1 specimen, under intertidal rocks, Rocky Point, Abaco Is.

Description. Shell (Fig. 29). See also DALL (1889) and DE JONG & COOMANS (1988). It is very characteristic in profile, coloration and nodules, which have an oblong form (Fig. 30).

Protoconch (Fig. 31) with 4 1/2 whorls. First whorl covered with minute hemispheric granules, that rapidly resolve into axial riblets mixed at the beginning with the granules. The second whorl shows only one spiral thread, there being two in the following.

Radula (Figs. 32 & 46 from the Bahamas specimen), with the formula 13-1-1-1-13. Central tooth with 3 similar cusps. Laterals with similar 5 cusps. Marginals 1-3 with 4 cusps, the 2 central ones filiform. From the marginal 4 there are only 3 cusps, the central longer, especially in the most external teeth.

Operculum paucispiral, with its spire of a quick increasing, translucent, without prominences.

Remarks. FABER & MOOLENBEEK (1991) included the present species in the genus *Latitriphora* apparently because of its similarity to the species included there by MARSHALL (1983). The radula of the present species is very similar to that of *Nototriphora aupouria* (Powell, 1937), but the shell is different. In any case, the radula of the type species of *Latitriphora* is unknown (MARSHALL, 1983), and so, we keep it provisionally in this genus.

There is no problem in separating the present species from the rest of the Caribbean triphorids, due to its elongated form and the very dense, axially elongated nodules.

Genus *Aclophora* Laseron, 1958

Type species (original designation): *Aclophora robusta* Laseron, 1958; Recent, Queensland, Australia.

Aclophora sagei n. sp.

Figs. 33, 34, 35

Material studied. Southern Cuba: 6 shells and 3 fragments, between 20-56 m, Cienfuegos Bay (type locality).

Type material. Holotype of 8.6 mm in the MNCN n° 15.05/17223. One paratype in IES, AMNH 226500, ZMA, CFG and 4 in the CER.

Description. Shell (Fig. 33) sinistral, slender and elongated, sharp, with a rectilinear profile and almost all of brownish colour.

Protoconch (Fig. 35) brown, with 4 1/2 whorls. First whorl covered with minute hemispherical tubercles. Subsequent whorls with axial riblets and two median spiral threads.

Teleoconch with two nodulous spiral cords on the early whorls and which are increased to three by the apparition of an adapical cord very close to the suture on about the fourth whorl. Moreover, there is a finer spiral thread at the suture. Spiral cords are crossed by axial ribs, which are a little wider than the cords, numbering 18-22 per whorl, Rounded nodules at intersections. Last adult whorl with 4 nodulous cords, the lowest of which forms a peripheral angulation; there are two more not nodulous cords towards the base. Aperture rounded, outer lip protruding, undulating and a little everted. Posterior sinus deep, open, inner lip with a pronounced callus. Siphonal canal rendered tubular at aperture by enfolding of outer lip, though open as a slit below; curved towards the back and overlaping shell profile. First two teleoconch whorls white, subsequent whorls brown, darker at the suture and on the base.

Etymology. Named after Walter E. Sage of the AMNH for his continued help in our research.

Remarks. We have doubts about the generic classification of this species. The spiral sculpture is somewhat similar to that *Eutriphora cana* (Verco, 1909), the type species of the genus *Eutriphora*, while the aperture in similar to that *E. armillata* (Verco, 1909), both of which were treated by MARSHALL (1983). The aperture and siphonal canal are also similar to those of *Aclophora xystica* (Jousseaume, 1884) and therefore we are keeping it provisionally in this last genus.

Several characters differentiate *A. sagei* n. sp. from the rest of the Caribbean species: its elongated and pointed form, the brown colour with the first whorls of the teleoconch white, the four spiral cords per whorl, the angulated periphery of the body whorl and the elongated siphonal canal.

"Triphora" osclausum n. sp.

Figs. 36, 37, 38

Material studied. Northern Cuba: 6 shells and 4 fragments, at 6 m, Jibacoa (type locality); 2 shells and 1 fragment, at 2 m, Comodoro, La Habana. Southern Cuba: 2 shells, at 10 m, Cayo Diego Perez; 2 shells and 1 fragment, at 20 m, Cayo Matías, Archipiélago de los Canarreos; 2 shells, at 20 m, Cienfuegos Bay.

Type material. Holotype (Fig. 36) of 4.5 mm in the MNCN n° 15.05/17224. One paratype in each collection of the following: IES, AMNH 226501, BMNH, ZMA, CFG, and 3 in the CER.

Description. Shell (Fig. 36 & 37) sinistral, ovoid elongated, sharp, with a slight curvilinear profile, uniform light brown.

Protoconch (Fig. 38) with about 4 whorls. First whorl covered by minute hemispherical granules, subsequent whorls with two similar spiral cords crossed by axial ribs.

Teleoconch initially with two nodulous spiral cords; another cord appearing about the fourth whorl, in the interspaces on, gradually enlarging to resembling adjacent spirals, and three or four whorls later the three cords are of equal size. These cords are crossed by axial ribs which are as wide as the cords, forming nodules at the points of intersections. Axial ribs 14-17 numbering on earlier whorls, 18-24 on later whorls. Last adult whorl with four nodulous cords, and two smoother ones on base. Aperture rounded, the outer lip prominent and spoon-like, not everted. Posterior notch deep, open. Inner lip with a slight callus. Siphonal canal enclosed at the aperture by a fold of the outer lip, short, curved towards the dorsum.

Etymology. The specific name is derived from the two Latin words *os* (mouth) and *clausum* (closed), because its aperture is a close circle.

Remarks. Comparison must be made with other triphorids of uniform brown colour, with which it was previously confused. *Marshallora modesta* can be differentiated by its overall darker colour, darker suture, more ovoid aperture, and outer lip with light cream border. Moreover, the siphonal canal in *M. modesta* is

shorter and not enclosed, and the anal sinus is shallower. The siphonal canal in *Marshallora nigrocincta* is not enclosed either (CLENCH & TURNER, 1959, pl. 38, figs. 11 & 14). Other Caribbean species with brown shells, such as *Cheirodonta apexcrassum* Rolán & Fernández-Garcés, 1984, *Isotriphora peetersae* (Moolenbeek & Faber, 1989) and *"Triphora" calva* Faber & Moolenbeek, 1991 have paucispiral protoconchs, while in *Mesophora novem* (Nowell-Usticke, 1969) and *Cheirodonta verbernei* (Moolenbeek & Faber, 1989), the first teleoconch whorls are white.

"Triphora" martii n. sp.
Figs. 39, 40, 41, 42

Material studied. Southern Cuba: 9 shells (some broken) and 1 fragment, at 20-40 m, Cienfuegos Bay (type locality).

Type material. Holotype (Figs. 39, 40 & 41) of 4.5 mm in the MNCN n° 15.05/17225. One paratype in AMNH 226502, IES, CFG, and 6 in CER.

Description. Shell (Fig. 39, 40 & 41) sinistral, ovoid elongated, sharp, rather wide in last whorls.

Protoconch (Fig. 42) with about 4 1/2 whorls. First whorl covered by minute hemispherical granules. Subsequent whorls have two spiral threads crossed by axial ribs.

Teleoconch with two spiral nodulous cords on all whorls. The upper cord close beside suture, separated from it by a small thread which is located very close to the cord. On the penultimate whorl an additional small cord appears below the adapical one, enlarging but never reaching the size of the cord above. The nodules are bigger on the upper cord, conneted to those on the lower cord by a few oblique ribs. The axial ribs almost disappear at base, where the width of the shell decreases, protruding the border of the aperture and the siphonal canal. Aperture rounded, with a deep sinus at the top of the aperture which is almost closed by a fold. Siphonal canal small, strongly curved towards dorsum, open, and crossed by a prolongation of the outer lip. Protoconch brown; teleoconch white, with a dark brown spiral line on the lower cord. That vanishes near apertura rim. Below this is another white spiral cord, and belower still there is a additional finer brown line.

Etymology. It is named in honour of the hero of the Cuban struggle for independence José Martí.

Remarks. This species must be differentiated from other banded triphorids on which the dark coloration is only present in a spiral line: *Iniforis turristhomae* and *I. pseudothomae* have a dark base that lacks the second brown line, with the anal sinus developing into a tube at some distance from the border of the lip. *I. carmelae* Rolán & Fernández-Garcés, 1993 has a paucispiral protoconch. *"Triphora" elvirae* has an elongated form, the third spiral cord appears before the penultimate whorl and, when a second brown line is present, it is immediately adjacent to the first one, without the intermediate white cord. *"T". ellyae* and *Eutriphora bermudensis* have dark bases and very different apertures.

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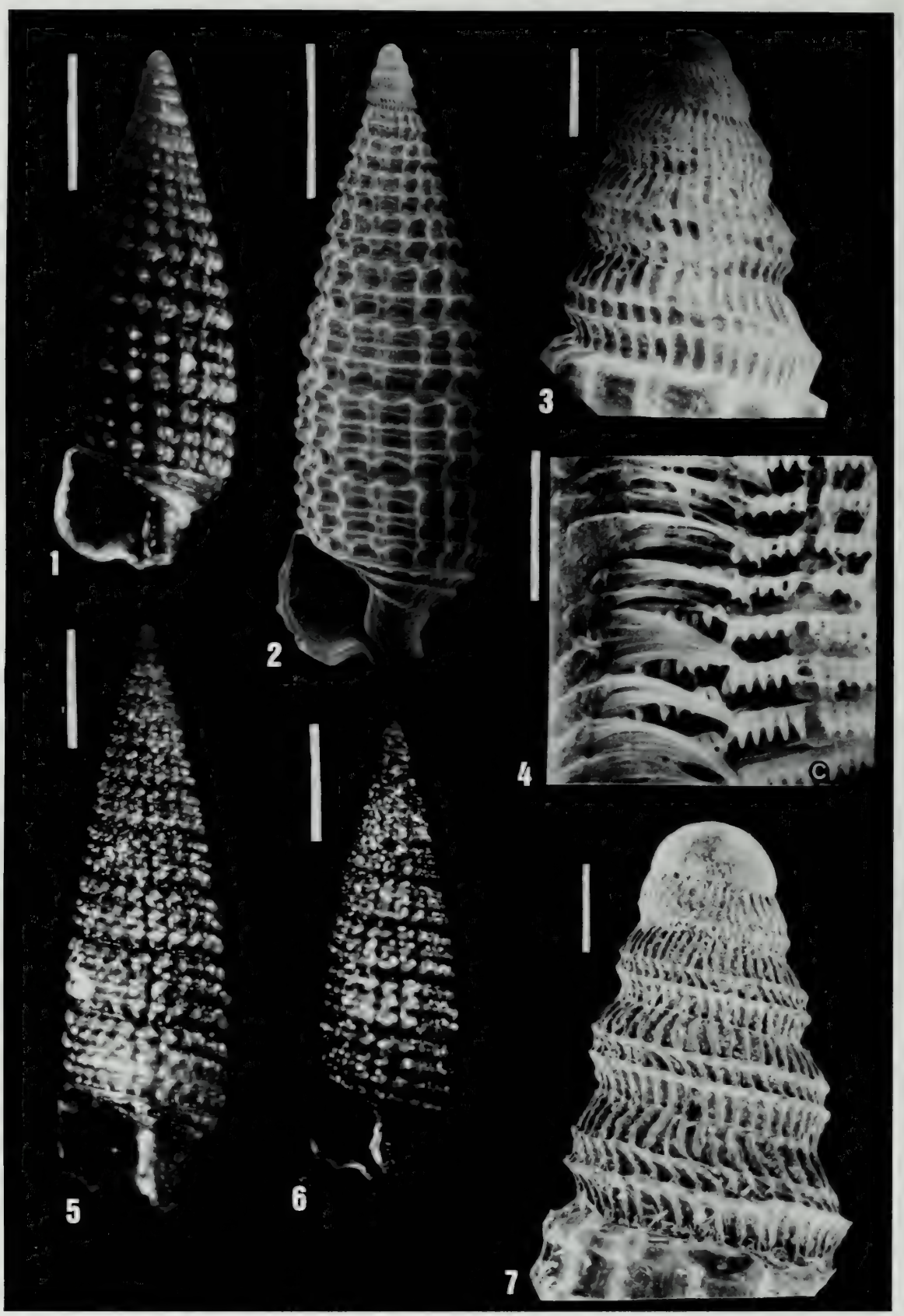
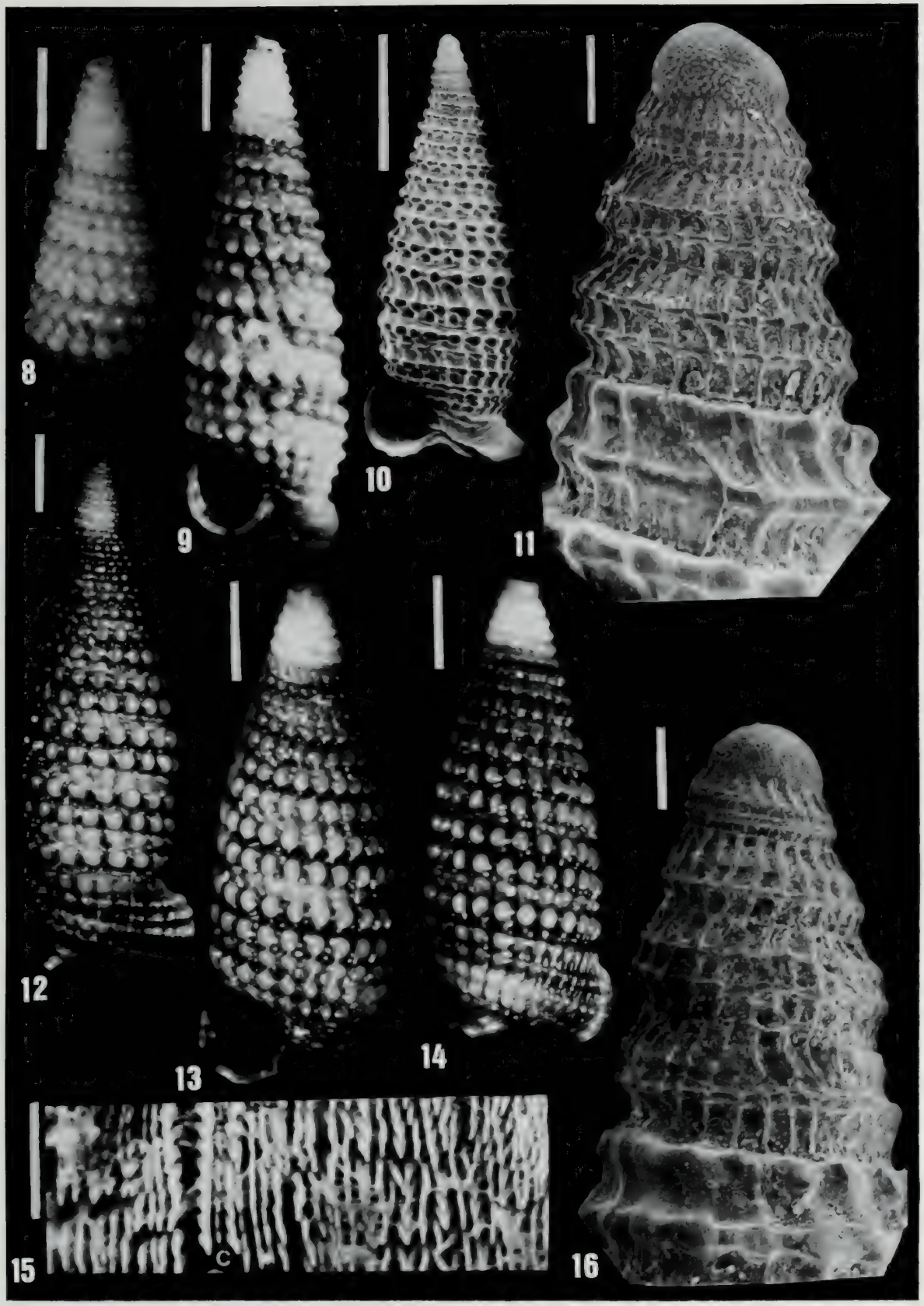


Figs. **1-7.**
1-2.- *Marshallora modesta*; **3**.- *M. modesta* (protoconch); **4**.- *M. modesta* (radula); **5-6**.- *M.* cf. *nigrocincta;* **7**.- *M.* cf. *nigrocincta* (protoconch). (scale bar: shells = 1 mm; protoconchs = 0.1 mm; radulae 0.01 mm)



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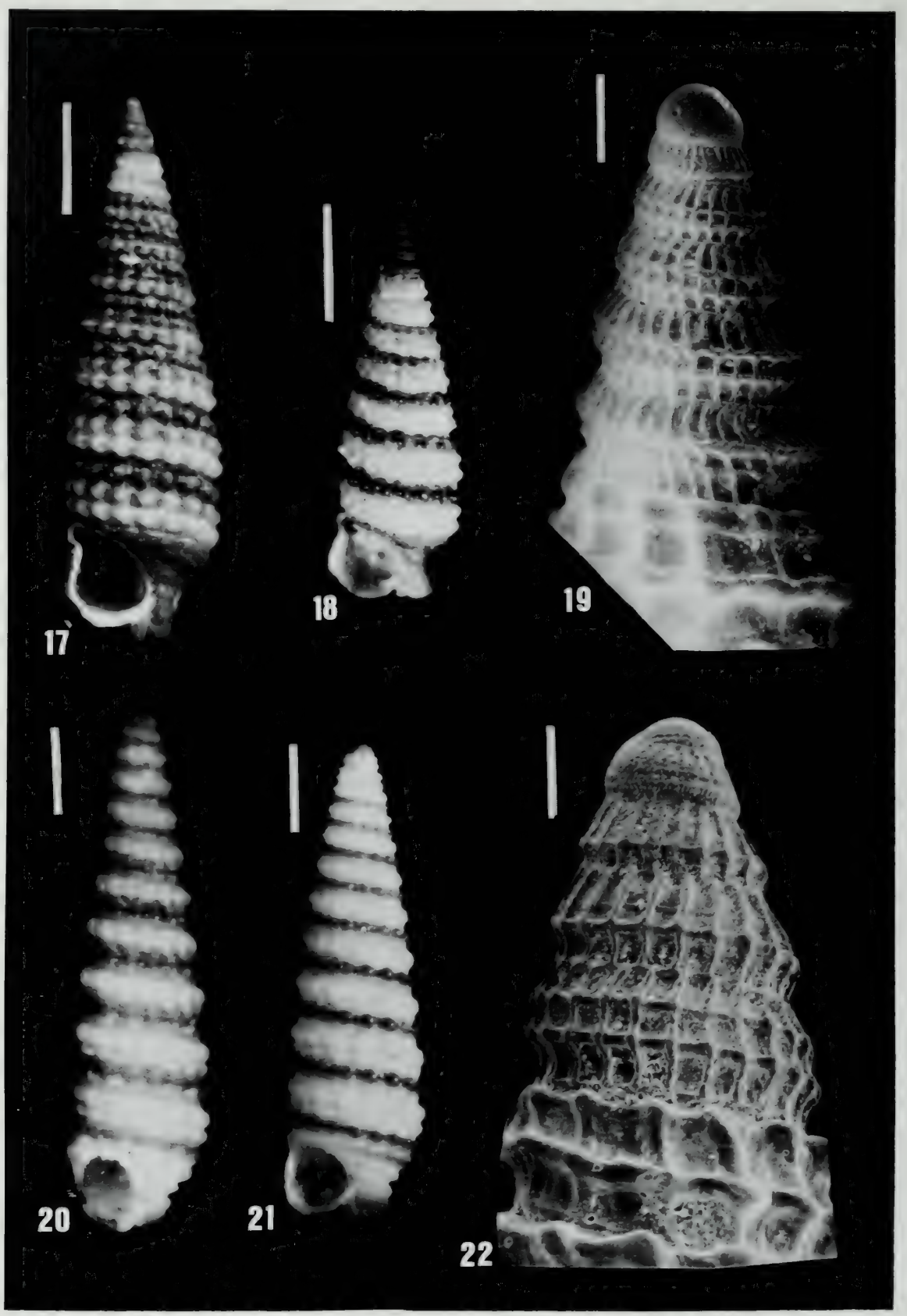

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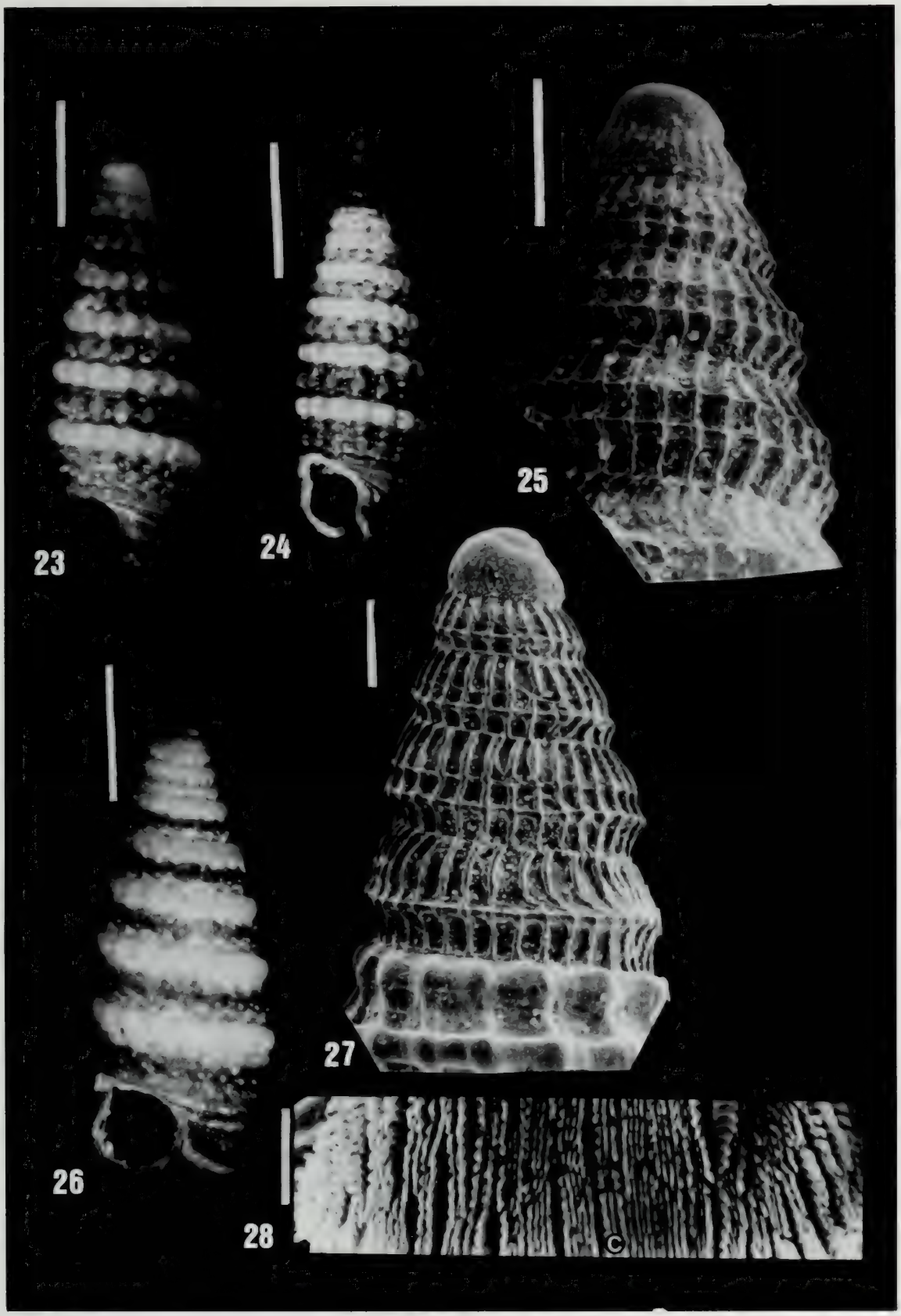

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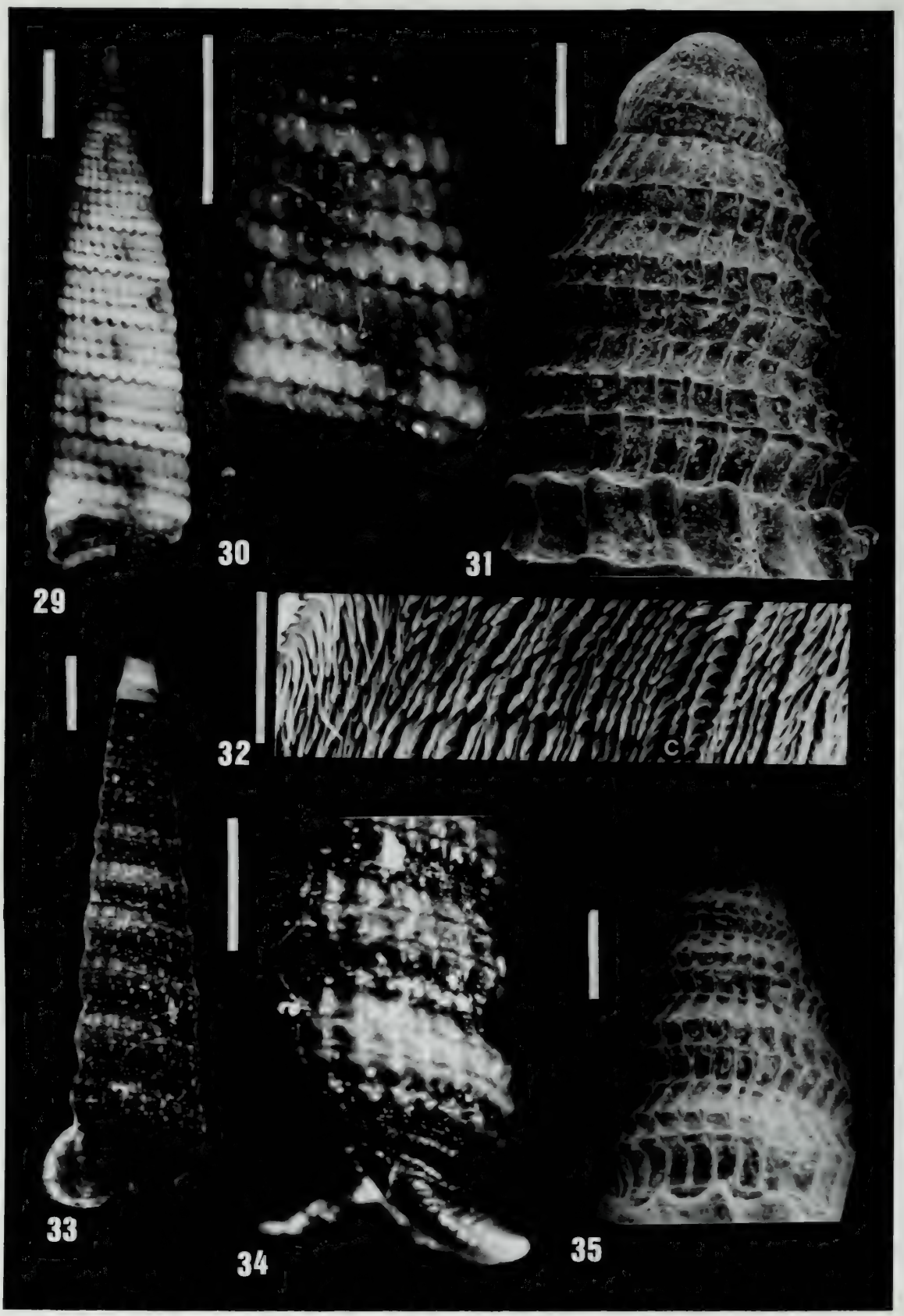

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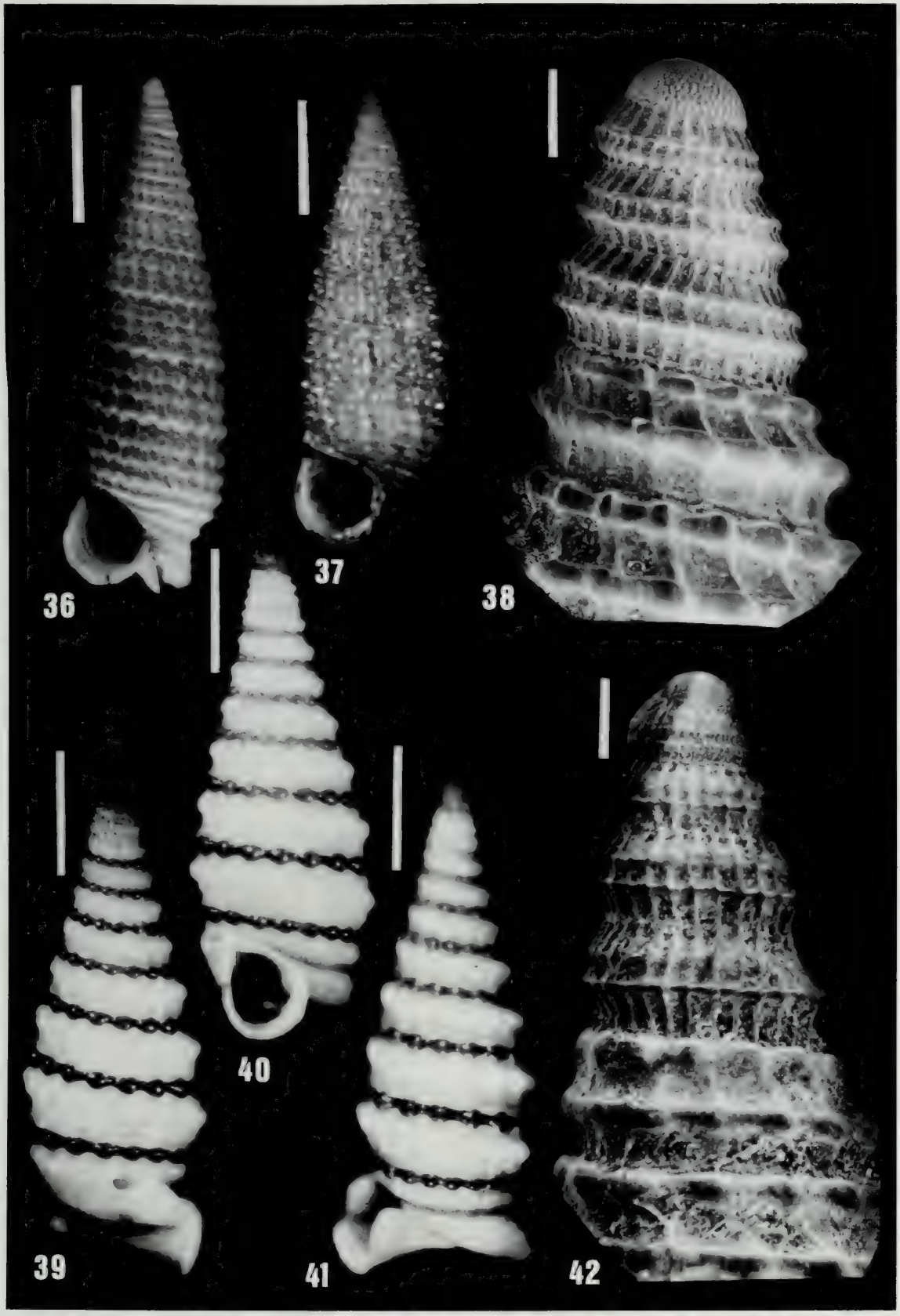

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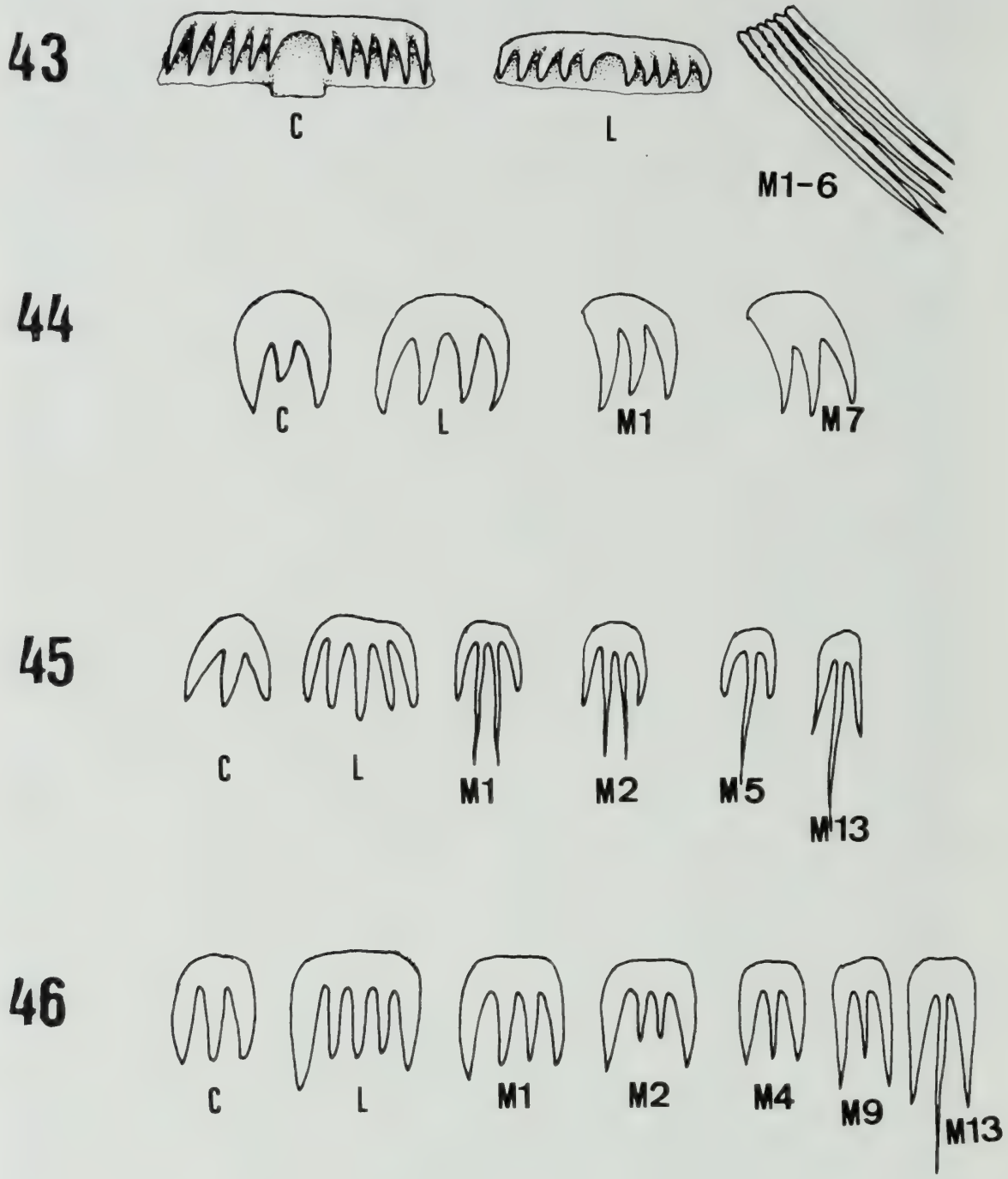

Figs. **43-46**.
43.- Radula of *Marshallora modesta*; **44**.- Radula of *Mesophora* aff. *novem;* **45**.- Radula of *Eutriphora bermudensis;* **46**.- Radula of *Latitriphora albida*. (C- central tooth; L- lateral tooth; M- marginal teeth)

Comment on the southern African limpets described from the Demidoff collection by Fischer von Waldheim (1807).

D. G. HERBERT

Natal Museum, P. Bag 9070, Pietermaritzburg, KwaZulu-Natal, 3200, South Africa.

KEYWORDS: Nomenclature, Patellidae, Siphonariidae, southern Africa.

ABSTRACT. *Patella bifida* and *P. spinosa* Fischer, 1807, are confirmed as junior synonyms of *P. barbara* Linnaeus, 1758, and *P. digitata* Fischer, 1807, as a senior synonym of *P. longicosta* Lamarck, 1819. *P. septemradiata* Fischer, 1807, is a synonym of *P. granatina* Linnaeus, 1758 (not of *P. longicosta* as suggested by IVANOV *et al.*, 1993). *P. rubrocostata* Fischer, 1807, is not a synonym of *Cellana capensis* (Gmelin, 1791), and is not a South African species. *P. serrata* Fischer, 1807, as defined by the lectotype, is a senior synonym of *Siphonaria aspera* Krauss, 1848.

In 1807 Fischer von Waldheim published the third volume of his catalogue of the 'Museum Demidoff' in which he described more than 100 new molluscan taxa (FISCHER, 1807). No illustrations were provided, locality data were rarely given and the majority of the names introduced have not been used by subsequent authors. IVANOV, KANTOR, SYSOEV & EGOROV (1993) have recently published a paper detailing the history of the Demidoff collections and discussing and illustrating the types remaining extant in the Zoological Museum of Moscow State University. In several instances the Demidoff material is clearly referable to species known from South Africa and IVANOV *et al.* (1993) made a number of suggestions concerning synonymy, some rather tentative. The purpose of this note is to clarify the position with respect to the limpet fauna of South Africa.

Patella bifida Fischer, 1807

IVANOV *et al.* (1993) stated "seems to be a junior synonym of *Patella barbara* L., 1758 (D. LINDBERG personal communication)". There can be no doubt that this is correct; the holotype is simply an example with well developed radial ribs which project strongly at the ventral margin.

Patella digitata Fischer, 1807

IVANOV *et al.* (1993) stated "probably a senior synonym of *Patella longicosta* Lamarck, 1819", which is undoubtedly correct. As a senior synonym, the name *P. digitata*, by the Principle of Priority, ought to be used in preference to *P. longicosta*. However, the younger name has been used extensively in both the scientific and popular literature, and its replacement with the earlier name would threaten the stability of a long established nomenclature. Accordingly, an application to suppress the name *Patella digitata* Fischer, 1807, for the purposes of the Principle of Priority, has been made to the International Commission on Zoological Nomenclature.

Patella rubrocostata Fischer, 1807

IVANOV *et al.* (1993) made no firm statement regarding this taxon, but the possibility that it represented a junior synonym of *Cellana capensis* (Gmelin, 1791) was raised. This is here rejected; both the lectotype and paralectotype (IVANOV *et al.* 1993, pl. 1, figs 4, 5) have much coarser radial ribs than occur in *C. capensis*. *P. rubrocostata* is not part of the southern African fauna.

Patella septemradiata Fischer, 1807

IVANOV *et al.* (1993) considered the holotype of this taxon to be a specimen of *Patella longicosta* Lamarck, 1819, and thus that *P. septemradiata* was a further senior synonym thereof. The holotype (examined on loan), however, is in reality a specimen of *Patella granatina* Linnaeus, 1758, having the typical tortoise-shell colour pattern and dark brown apical blotch on the interior. *P. septemradiata* must therefore be placed in the synonymy of *P. granatina*.

Patella spinosa Fischer, 1807 [non Gmelin, 1791]

IVANOV *et al.* (1993) were not able to arrive at a definite conclusion regarding this taxon. Examination of the holotype indicates that, like

P. bifida, it is simply a strongly stellate example of *P. barbara* Linnaeus, 1758, and must be placed in the synonym thereof.

Patella serrata Fischer, 1807

The two specimens mentioned by Fischer were both illustrated by IVANOV *et al.* (1993); they almost certainly represent different species. The specimen designated lectotype by IVANOV *et al.* (1993) is, as suggested, a species of *Siphonaria* Sowerby, 1824, and is clearly conspecific with the southern African species currently known as *Siphonaria aspera* Krauss, 1848 (lectotype in Stuttgart Museum, illustrated by JANUS, 1961). The paralectotype of *P. serrata* is almost certainly a specimen of *Trimusculus costatus* (Krauss, 1848).

As in the case of *P. longicosta* Lamarck, 1819 (=*P. digitata*), the Fischer name is the senior synonym. In this instance, however, the species is not well known and *Siphonaria aspera*, though the long accepted name for the species, has not been used extensively in the literature; since a well established nomenclature is not threatened, application to the ICZN for the suppression of *Patella serrata* would serve little purpose. The older name has already been reintroduced into the literature (CHAMBERS & MCQUAID, 1994).

Acknowledgements

I would like to thank Dimitri Ivanov for the loan of type specimens from the Zoological Museum of Moscow State University, and George Branch, Richard Chambers and Dick Kilburn for comments on the manuscript.

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A new species of the genus *Falsilatirus* Emerson & Moffitt, 1988 (Gastropoda: Fasciolariidae) from the Philippine Islands.

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KEYWORDS: Gastropoda, Fasciolariidae, *Falsilatirus suduirauti* n.sp., Philippines.

ABSTRACT. A new species belonging to the genus *Falsilatirus* is described from deep water off Central Philippines. This is the second species recorded for the genus introduced by Emerson & Moffitt and tentatively placed in the family Fasciolariidae.

INTRODUCTION

In recent years deep water shell fishing traps operating in the Philippine Islands have been a very important source of material for study. The new taxon here described is of special interest, being the second known species belonging to a genus of questionable position: *Falsilatirus*. EMERSON & MOFFITT (1988) introduced this name attempting to place taxonomically a previously unknown species of prosobranch gastropod found in traps, operating in deep waters off the Mariana Islands. This placement has been made considering mainly the presence of a prominent spiral columellar fold, but other shell characters do not support this attribution. Soft parts must be available for a definitive placement of the genus.

SYSTEMATICS

Genus: *Falsilatirus*
Emerson & Moffitt, 1988
Type species: *Falsilatirus pacificus* Emerson & Moffitt, 1988 (by original designation)

***Falsilatirus suduirauti* sp.n.**
Figs 1-4.

Description. Shell solid, high spired, protoconch papillose, paucispiral, consisting of 1.5 smooth whorls. Teleoconch of 7 convex, subangulate whorls, separated by deeply impressed, wavy suture. Spiral sculpture of primary cords extending just from over shoulder to lower sutural line on spire, to siphonal canal on body whorl: 18 cords on body whorl, 8 on penultimate, decreasing in number on previous whorls; presence of minor cordlets in interspaces between primary cords. Axial sculpture of 7 strong elongate nodules per whorl and of fine microcostulation on entire shell surface. Aperture irregularly outlined; outer edge raised, sharp, with 8 submarginal fold-like denticles: posterior denticle isolated, others partially fused, decreasing in strength anteriorly, columella with 2 central denticles. Shell surface evenly stained of pale yellow, peristome white, inside of aperture yellow.

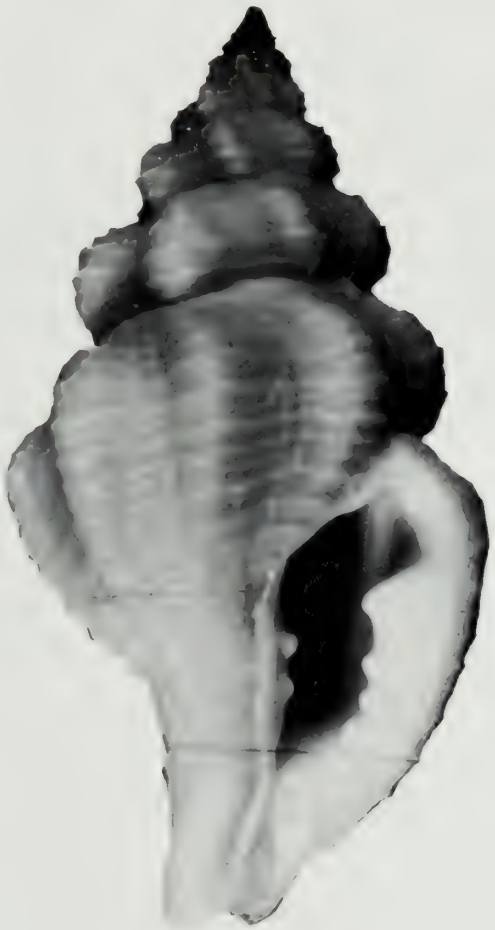


Fig. 1. *Falsilatirus suduirauti* sp.n., holotype MNHN, 32.85 mm.

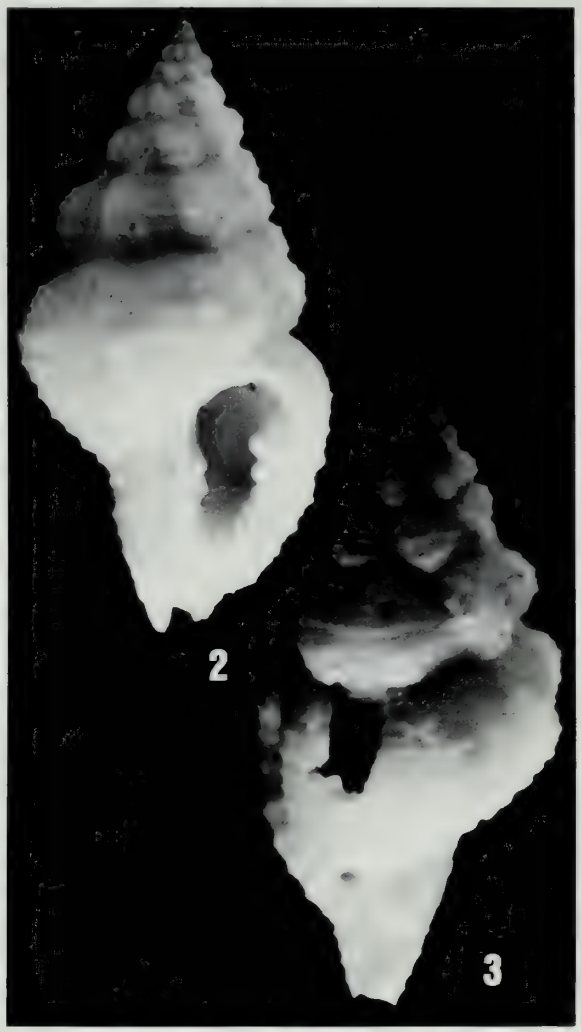
Type Material. Holotype: 32.85 x 17.3 mm, MNHN, paratype: 32.05 x 16.8 mm, author's collection. Holotype live taken, paratype crabbed.

Type Locality. Balut, Mindanao Island, Central Philippines; 140-180 m.

Discussion. *Falsilatirus suduirauti* is similar to *F. pacificus* Emerson & Moffitt, 1988 in the general characters. It differs in the uniform staining, in the more numerous axial nodules (7 versus 5), spiral primary cords (6-8 versus 3-4 on spire whorls, 18 versus 12 on body whorl) and labrum denticles (8 versus 6) and in the more developed siphonal canal.

Etymology. This species is named after Mr Emmanuel Guillot de Suduiraut who personally fished the specimens and generously donated them for study purposes.

Acknowledgments.
I am greatly indebted to Roland Houart for the cooperation.



Figs. 2-3. *Falsilatirus suduirauti* sp.n., paratype coll. Bozzetti, 32.05 mm.

REFERENCE

EMERSON, W.K. & R.B. MOFFITT, 1988. A New Genus and Species of Prosobranch Gastropod (?Fasciolariidae) from the Mariana Islands. *Veliger* 31(1/2): 43-45.

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Jean, François BUYLE, 1915-1995.

Membre fondateur de de la Société Belge de Malacologie en 1966, notre collègue en était Trésorier depuis 25 ans et a pris une part active à la vie de notre Société. Il possédait une connaissance approfondie de la malacologie. En s'appuyant sur une vaste collection personnelle et des études bibliographiques, il nous a présenté, au fil des ans, 34 causeries abordant les sujets les plus divers. Il nous a laissé, par ailleurs 11 articles publiés dans nos différentes revues. Son décès inopiné nous fait perdre un ami affable, érudit et serviable.

Le présent numéro de APEX est dédié à sa mémoire.

Founder member of the *Société Belge de Malacologie* in 1966, our colleague has been its Treasurer for 25 years. He played an important role in the life of our Society. His deep knowledge of malacology, a large personal collection and bibliographical studies allowed him, along the years, to give us 34 lectures, on the most diverse subjects. He has left 11 papers, in our different publications. His untimely death deprives us from an affable, erudite and helpful friend.

This number of APEX is dedicated to his memory.

On the structure of a population of *Oliva oliva* (L., 1758) in Papua New Guinea (Studies on Olividae. 22)

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KEYWORDS: Mollusca, Gastropoda, Olividae, *Oliva oliva*, size, colour.

SUMMARY. Monthly samplings of the population of *O. oliva* on the black sand beach of Sisimangum (Hansa Bay, Papua New Guinea) were effected during 8 months. The very sharp size frequency distribution did not vary appreciably and suggests a high mortality at about half of the maximum size. No significant change was observed in the distribution of shell colour classes. Predation pressure is high: counts of the presence of scars on the shell show that most of the specimens have survived an unsuccesful attack. The distribution of scars suggests that the responsible predator(s) form a "search image" adjusted to the most abundant class of prey (16-20 mm black shells). Such apostatic selection could stabilise the balanced colour polymorphism observed in the population. Abrupt changes in shell colour were experimentally induced by maintaining black specimens on white sand. These induced colour shifts allow an estimation of the growth rate, which averages 4.0 mm/year (for shells in the 13-22 mm range).

RESUME. Des prélèvements mensuels de la population d' *O. oliva* vivant sur la plage de sable noir de Sisimangum (Hansa Bay, Papouasie Nouvelle-Guinée) ont été effectués pendant huit mois. La distribution très pointue des fréquences de taille n'a pas varié appréciablement et suggère une mortalité élevée à environ la moitié de la taille maximale. Aucun changement significatif n'a été observé dans la distribution de la couleur des coquilles. La pression de prédation est forte: le comptage de la présence de cicatrices sur les coquilles montre que la plupart des spécimens a survécu à une attaque infructueuse. La distribution des cicatrices suggère que le(s) prédateur(s) responsable(s) forme(nt) une "image de chasse" centrée sur la classe de proies la plus abondante (coquilles noires de 16-20 mm). Une telle selection apostatique pourrait stabiliser le polymorphisme de couleurs observe dans la population. Des changements abrupts de la coloration de la coquille ont été induits expérimentalement en maintenant des spécimens noirs sur du sable blanc. Ces changements de couleur induits permettent d'estimer la vitesse de croissance à une moyenne de 4.0 mm/an (pour des coquilles de 13 à 22 mm).

1. INTRODUCTION

No data whatsoever are available on the basic biological parameters (growth, reproduction, longevity, etc ...) of any *Oliva* species, in spite of the abundance of these animals in the tropical Indo-Pacific region. This paper presents the results of a survey of a population of the type species of the genus, *Oliva oliva* (Linnaeus, 1758), in Hansa Bay (Papua New Guinea). It reports some unexpected observations, but yet raises more questions than it gives answers.

In Hansa Bay, *O. oliva* is restricted to the low water level on soft, sandy beaches directly exposed to frequent surf. In twenty years of survey it has never been found in any other biotope (with the exception of a few juveniles collected around a World War II wreck, 6 m). This narrow niche might explain why *O. oliva* appears to be (at least in our hands) much more difficult to keep in aquaria for prolonged periods of time than many other *Oliva* species.

Oliva oliva is polytopic and cryptic (see VAN OSSELAER et al., 1994). The matching of shell colour to background colour strongly suggests cryptic adaptation to counter diurnal predation by hunters endowed with good vision. During previous experiments in aquaria, a mixed group of black and white olives were given a choice between black and white sand. Only 52.9 % of the black *Oliva* preferred black sand (non significant) while 63.5 % of the white *Oliva* actually preferred black sand

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(significant at 0.05). The observed matching of shell colour with sediment colour is therefore not likely to be the result of a choice by the *Oliva* but most probably results from selective predation (VAN OSSELAER, BOUILLON & TURSCH, 1993). In another series of aquarium experiments, reported in the same paper, *O. oliva* was shown to be much more mobile during the night than during the day, like its rather distant relative *Olivella biplicata* (see PHILLIPS, 1977). Only 14-27% of the small *O. oliva* and none of the large specimens do move during daytime. Mobility is not affected by the colour of the substrate and is not correlated to the colour of the shell. Olives are carnivorous, eating small bivalves, small gastropods, dead flesh, etc. that they could obtain equally well by daytime. This suggests that their nocturnal activity could also be a counter-adaptation to diurnal predation (VAN OSSELAER, BOUILLON & TURSCH, 1993).

Two colonies of *O. oliva* are present in Hansa Bay (specimens of both are illustrated in TURSCH, 1994). One small population lives on white, coarse coral sand at Boro Beach, where heavy swell is generally prevalent. Specimens from Boro reach a moderate size (H_{max} 33.15 mm). All 42 specimens collected are "white" (see § 2.2) and have an elongated spire. The aperture is short and consistently reddish brown.

Another population (this one very large) extends all the way from the northern tip of the bay to the mouth of the Sakula River, on fine, dark volcanic sand, with occasional, moderate swell. Specimens from Sisimangum reach a larger size (H_{max} 42.31 mm). On nearly one thousand specimens collected, 72.1 % are "black", 17.3 % are "white" and 10.6 % do not fit into these categories (see § 3.1.4). The spire is short, the aperture long and mostly dark purple. Most shells of this population very closely match the two syntypes of *O. longispira* Bridgman, 1906 (British Museum, Natural History : 1906.7.4.9-10).

These two very distinct populations actually come within 1.5 km of each other, separated by a rocky point and the mouth of the small Sakula River. Their characters have been stable for more than 20 years (see TURSCH, 1994) and we have never observed any intergrading specimen. Such isolation would in theory simplify studies on populations dynamics, since one could presumably neglect the influence of immigration and emigration.

At Sisimangum Beach, *O. oliva* is by very far the dominant species of *Oliva*. A total sample of about one thousand specimens collected over eight months contained less than 10 specimens of other species. At the turn of the low tide, it crawls in great numbers on the lower stretches of the beach, offering a good opportunity for the comparing sizeable monthly collections without depleting the population.

2. MATERIAL and METHODS

2.1. Collection.

Monthly collections of *O. oliva* were made from February to September 1992 on the beach at Sisimangum, at the turn of a strong low tide. This period encompasses both the rainy and the dry season. The dates of collections are: February 2, March 9, April 10, May 12, June 6, July 10 and September 11.

All specimens seen were collected until the desired number of animals (approx. 100) was obtained, and preserved in 40% alcohol. It is important to stress that, for nearly all captures, the collector sees only a track in the sand, at the extremity of which the animal lies buried under a little protuberance of sand. In these conditions, neither the colour nor the size of the animal can be known *a priori*. The samples are presumably without bias, excepted for very small shells (< 10 mm?) that will tend to be overlooked.

2.2. Observations on preserved specimens.

Shell length (H) was measured to 0.01 mm with a digital display calliper, from the apex to the distal part of the aperture (see TURSCH & GERMAIN, 1985). The expression "adult shells" refers to large shells with a thickened lip.

The shells were sorted into three rough, arbitrary colour classes ("black", "white" and "others"). The spire of *O. oliva* shows that there is often a progressive darkening of the background colour in the very early whorls. This could cause some confusion between "white" and "others" for very small specimens (< 10 mm).

Each specimen was examined under magnification to detect the presence of scars on the shell. Errors on the frequency of scars would necessarily be underestimations. As the animals live on a large stretch of smooth sand, collisions with hard objects are most improbable, so all scars are deemed to result from attacks by predators.

2.3. Observations on live specimens.

All experiments were carried out at King Leopold III Biological Station, at Laing Island, Hansa Bay. White painted (epoxy) marine plywood aquaria, equipped with an open circulation of natural sea-water flowing slowly from a storage tank, were placed under an open corrugated iron shelter shaded with curtains of fishing net. Specimens were fed once a week with meat morsels. Two different sediments (one black, terrigeneous fine sand of volcanic origin collected at Sisimangum Beach, and one white, coarse coral sand collected on the East coast of Laing Island) were used for substrate effect experiments. Analysis of both substrates has been given in VAN OSSELAER *et al.* (1994).

3. RESULTS and INTERPRETATION

3.1. Analysis of monthly samples.

3.1.1. Size frequency distribution. This study started by the casual observation that a sample of 109 *O. oliva* collected at Sisimangum Beach on February, 2, 1992 had a very sharp, quite unexpected distribution of sizes, given in Fig. 1. This contrasted with the much flatter distributions generally observed for other molluscs (see for instance JONES, FERRELL & SALE, 1990). It was also at sharp variance with the observation that "*Olivella* populations are often primarily composed of large, slow-growing animals" (EDWARDS, 1969, referring to several size frequency distributions, from different localities). This is also the impression given by other common shoreline *Oliva* populations in Hansa Bay (*O. elegans*, *O. caerulea*, etc.) in which "adults" are much more numerous than young shells (unpublished results).

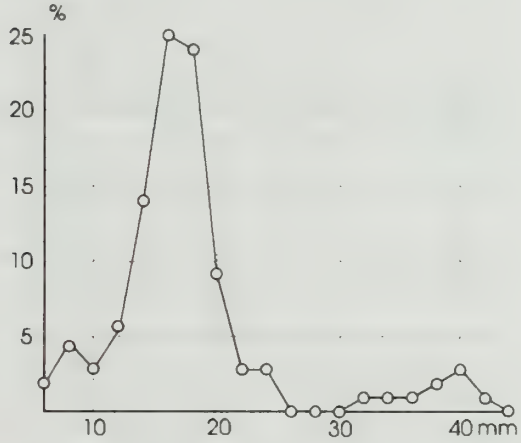

Fig. 1. Distribution of sizes, in percentage of total. Sample: February 1992 (N=109).

"Adult" *O. oliva* shells reach a length of over 40 mm in this locality. The sharp peak at 16-18 mm, well separated from a small peak of "adult" shells, was first interpreted as corresponding to an age cohort (siblings from a same clutch of eggs or class resulting from synchronous reproduction). If this was the case, we would have a tool to estimate the growth rate of *Oliva oliva* in natural conditions. All we had to do was to repeat collecting samples at regular intervals of time, measure the expected shift of the distribution peak towards larger sizes and calculate the rate of growth (for examples of this technique, see LOREAU & BALUKU, 1987 and BALUKU & LOREAU, 1989). Monthly collections were therefore effected from February to September 1992.

3.1.2. Contrary to such expectations, a very similar distribution of sizes was observed month after month (see Fig. 2). The distribution of sizes for all the shells caught during the eight months period is depicted in Fig. 3. It is strikingly similar to that of Fig. 2 (although "adult" shells appear to be even rarer than presumed earlier).

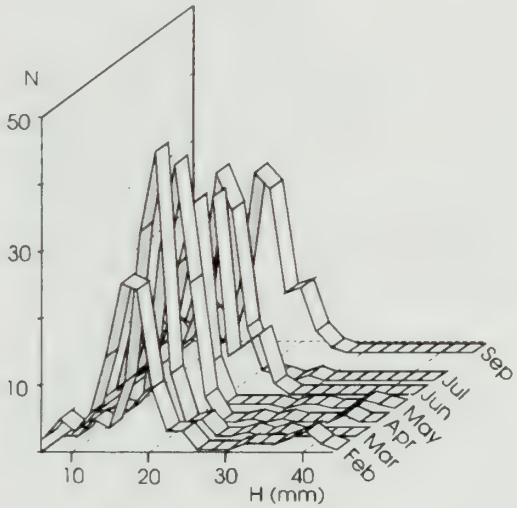

Fig. 2. Distribution of sizes. Total of all samples: February to September 1992. (N=991).

From Fig. 3 we can see that young individuals between 14 and 22 mm constitute over 75% of the population, and those between 16 and 20 mm amount to 55%. The chances for a specimen of *O. oliva* to reach "adult size" are very dim: only about 1% of the population reaches 38-42 mm. The small irregularity at the left of the peak (towards small sizes) will not be interpreted, as it could result from non-random collection of very small specimens

(their traces in the sand are not easy to detect). There should be no such problem for shells of 12 mm and above.

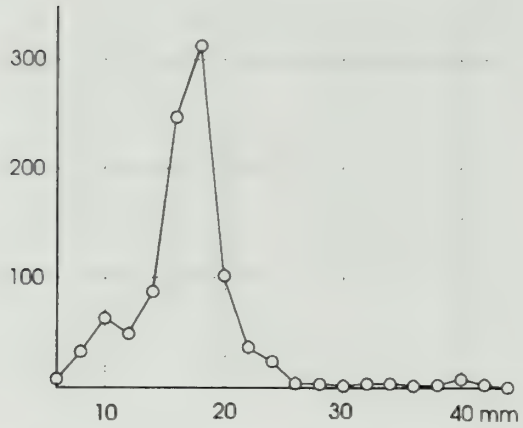

Fig. 3. Distribution of sizes. Total of all samples: February to September, 1992. (N= 991).

4	*N*	mean	median	mode
Feb.	109	18.65	17.5	19.0
March	160	18.31	18.3	18.3
April	182	18.85	18.8	18.6
May	167	17.00	17.6	18.3
June	122	17.37	18.1	18.1
July	128	16.53	17.3	19.2
Sept.	123	17.38	17.8	17.6

Table 1. Means, medians and modes of monthly collections.

3.1.3. The mean, the median and the mode of all monthly collections are compared in Table 1. There is no indication whatsoever of an increase in size. The hypothesis of the age cohort should be abandoned, unless one is willing to accept that the growth of *O. oliva* is so extremely slow that it cannot even be detected within eight months.

It is much more likely (see Discussion, § 4.1) that the observed distribution results from a dynamic equilibrium between growth and massive mortality (starting at a size around 16-18 mm). As the size frequency distribution (Fig. 2 and Table 1) is very stable, it follows that this mortality must vary little throughout the year.

3.1.4. Colour classes frequency. On nearly one thousand specimens of *O. oliva* collected from February to September 1992, 72.3 % were "black", 17.9 % "white" and 9.8% "others". The relative proportions of these colour classes did not change much during the eight months of observations (see Fig. 4). The relative proportions of "black" shells in February and in September is the same (72.5%), indicating that the observed fluctuations are probably due to sampling.

This observation indicates the relative objectivity of our arbitrary colour classes: should the colour composition of the sample have changed, it is unlikely that, on seven occasions, our error would have been just the values required to offset the variation.

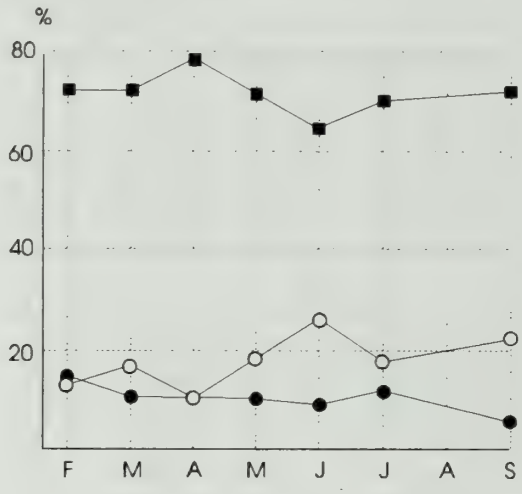

Fig. 4. Colour composistion of all samples (February to September 1992), in percentage of monthly total. Black squares: "black" shells. White circles: "white" shells. Black circles: "others".

3.1.5. Frequency of scars. To acquire some indirect information on predation, the presence of scars was counted on all shells, without distinction of the type or the size of scar. For correlation studies, to deal with significant samples, the shells were ordered into six arbitrary size intervals (selected so that the classes are of comparable size, N>86 for each class). All observations are summarised in Table 2.

3.1.6. At least one scar on the body whorl was observed on 42.5 % of all shells. As all the shells have several whorls, one can conclude that the vast majority of *O. oliva* living at Sisimangum) have survived at least one unsuccessful attack from a predator. This high frequency of surviors also means that the characteristics of the shell are effective in protecting the gastropod against fatal breakage (VERMEIJ, 1982).

size (mm)	"black"			"white"			"others"			Total
	no scar	with scar	Total	no scar	with scar	Total	no scar	with scar	Total	I
< 12	46	11	57	27	3	30	12	7	19	106
12 to 15.99	50	42	92	13	12	25	10	10	20	137
16 to 17.99	85	94	179	26	16	42	21	5	26	247
18 to 19.99	118	134	252	22	16	38	15	7	22	312
20 to 21.99	36	38	74	13	5	18	6	4	10	102
> 22	49	12	61	14	4	18	6	2	8	87
total	384	331	715	115	56	171	70	35	105	991

Table 2. Distribution of scars per shell size and colour.

The percentage of scar-bearing shells is correlated to shell colour. On the total sample (N=991), scars were found on 46.3 % of the "black" shells, 32.7 % of the "white" shells and 33.3 % of the "others". The sample being large, the difference between the frequencies of scar-bearing "black" and "white" shells is highly significant (at the 0.01 level, two-tailed Student's *t*-test, *t*=3.177). For "black" *vs.* "others", the difference is significant (at the 0.05 level, *t*=2.233. For "white" *vs.* "others", the difference is not significant.

That "black" specimens suffer more attacks was a rather unexpected observation. The population of *O. oliva* under study lives on black sand, where one would expect "black" shells to be attacked less often than "white" ones.

The percentage of scar-bearing shells is correlated not only to shell colour but also to shell size: it is over 46 % for shells between 12 and 22 mm, but only about 20 % for smaller or larger specimens. For shells between 16 and 22 mm (66.7 % of the population), scars are observed on 53 % of the "black" shells (51 % of total population) but only on 34 % of all others ("white"+ "others", 15.7 % of total population).

Based upon the frequency of scar-bearing shells, maximum predation corresponds to the most abundant category: "black" shells between 16 and 22 mm.

3.2. Induction of colour changes.

3.2.1. As on many other molluscs, colour shifts are occasionally observed on *Oliva* shells. A generally abrupt change in background coloration occurs along a growth line and the mollusc often continues building its shell with a distinct, new background colour. Sometimes the mollusc reverts to its original colour and the event results in a more or less wide longitudinal stripe. In some rare instances the phenomenon is repeated, resulting in several parallel stripes.

As crypsis (matching shell colour with the colour of the substrate) appears quite general amongst *Oliva* species (VAN OSSELAER, BOUILLON & TURSCH, 1993), it was tempting to check if shifts in shell colour could be experimentally induced by changes of substrate. That such colour changes could be induced by external events had already been proposed by GREIFENEDER (1981b), who observed apparently synchronous colour shifts on the shell of populations of the East African *O. bulbosa* and suggested that such changes could be used as a "chronicle of the habitat".

3.2.2. Induced colour shifts would be easier to observe is growth rate is rapid. One had therefore to experiment on young individuals, the growth of which being well known to be faster. 23 black specimens (mean size: 15.63 mm, average deviation 2.39), were collected on the black sand of Sisimangum beach and placed in an aquarium containing white sand (see Methods, § 2.3). The experiment started on April 9, 1993, and ended on November 21, 1993. Observations are summarised in Table 3. *O. oliva* is not the easiest *Oliva* to keep in aquarium (see Introduction), and a number of specimens (accounted for in the Table) died before that date.

Colour changes were induced in 19 (82.5 %) of 23 tested specimens. The induced colour shifts are very clearly marked, as seen on Fig. 5. No such colour change could be detected in a control group of black specimens kept in the

same conditions, but on their original black substrate.

Simultaneously with the above experiments, a group of 22 white specimens (mean size: 15.38 mm, average deviation 3.51), collected together with the previous lot, were kept on their original black sand, in the same conditions. None of the 22 specimens exhibited any colour shift.

Experimental induction of colour shifts also allows an estimation of the growth rate of *O. oliva* (at least in the size range H=13 to 22 mm). One can easily measure the number of postnuclear whorls before and after the colour transition, as this occurs rapidly and quite abruptly.

On the twenty specimens in which a colour change was observed a mean angular growth of 0.38 volution/year was found (max: 0.65; min: 0.25). The plot of shell length (H) *vs.* the number of postnuclear whorls (pnw) is given in Fig. 6 for the 20 specimens under consideration here. For a rough approximation, we can consider that the relation is linear, (the size interval being of only a few millimetres). From this graph one can estimate the mean linear growth as being roughly 4.0 mm/year (max: 7.5; min: 3.0). From the observed growth rate, a large (40 mm) *O. oliva* would be about 10 years old. This is certainly an underestimation, because growth rates are well known to decrease with size.

date		colour change	no colour change	elapsed time (days)
June 29	2 dead	1	1	81
Oct. 24	2 dead	2	0	198
Nov. 7	2 dead	2	0	212
Nov. 16	3 dead	3	0	221
Nov. 20	3 dead	2	1	225
Nov. 21	end exper.	9	2	226
	total	19	4	

Table 3. Induction of colour shifts. 23 "black" specimens originating from black sand and kept on white sand.

Fig 5. Experimental induction of colour changes in the shell of O. oliva. 1-4: "black" specimens collected at Sisimangum Beach (black sand) and kept in aquarium for 226 days on white sand. Scale bars: 10 mm.

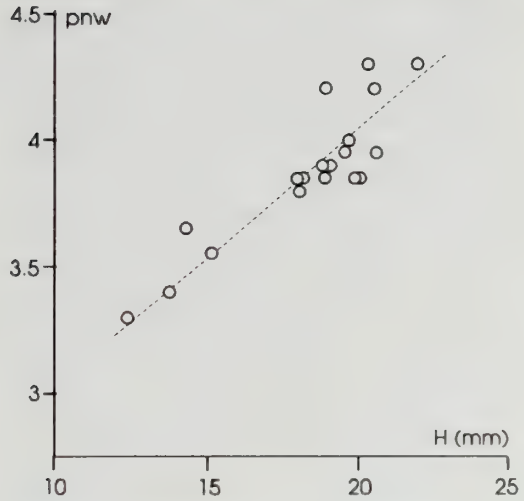

Fig. 6. Shell length (H) *vs.* number of postnuclear whorls (pnw). 19 specimens with induced colour change (see text § 3.2.2).

4. DISCUSSION

4.1. Size frequency distribution.

The sharpness of the size distribution peak was first interpreted as indicating an age cohort. This hypothesis raises serious difficulties. First, where are the other age cohorts?

Their absence could be explained if there was a segregation of habitats according to age classes. Indeed, GREIFENEDER (1981) called attention upon the fact that juveniles of some Olividae species (*Olivella biplicata, Olivancillaria auriculata*) are mostly found in deeper water. This is the contrary of what happens here: predominance of young shells in the intertidal zone. In the particular case of the very abundant *O. oliva* population of Sisimangum Beach, the hypothesis of habitat segregation seems untenable. Over the last 20 years, the beach has been carefully combed on many occasions over large distances, the area has been frequently dredged (from the shore to beyond -35 m), and nearly one hundred dives effected in the vicinity, without any indication of age-related habitat segregation. Not a single specimen of *O. oliva* was found during recent series of quantitative quadrats effected at -3, -5, -10 and -15 m off Sisimangum (VAN OSSELAER, 1992).

A second, admittedly far-fetched explanation would be that reproduction of *O. oliva* occurs synchronously, and at such large intervals of time (ten years or more) that a second peak would not have the time to appear. This hypothesis seems most improbable: we are not aware of the existence of such a long reproductive cycle in any gastropod. Furthermore, the several *Oliva* species we have kept in aquaria seem to lay eggs all year round (this is also the case for *Olivella biplicata*, see STOHLER, 1969).

In any case, the stability of the peak in time (no increase of size could be detected, see Table 1) makes very unlikely that it represents an age cohort.

But then, why such a sharp peak? By far the most probable explanation is that our stable size frequency distribution curve reflects an equilibrium between steady growth and a steady mortality. The sharp increase in size frequencies (left side of the peak) is understandable: for all animals, growth is expected to be much faster at very small sizes. Rapid transit of young specimens through the small size classes would produce exactly the observed result. It is the sharp decline of the distribution curve that requires an explanation. One would expect a much flatter, regular decrease of the curve unless shells above a given size undergo a specially high mortality. By proper adjustment of parameters, computer simulations (not given here because a simulation does not prove anything in this case) do yield quite comparable distribution curves. The data at hand suggest massive mortality, especially at a size around 16-18 mm. As the size frequency distribution (Fig. 2) is very stable in time, it must follow that this mortality varies little during the year.

The observed phenomenon is possibly not unique to Hansa Bay: Dr. Dietmar Greifeneder (personal communication) has observed a very similar size distribution on a large (probably unbiased) lot of *O. reticulata* collected at Kesuma Sari (Bali) by the late Renate Wittig-Skinner (WITTIG-SKINNER, 1981). The sample, sorted into 2.5 mm size classes (from 10-12.5 mm to 42.5-45 mm) has a very sharp size frequency peak at 20-22.5 mm.

4.2. Predation.

What could cause such a massive mortality? We know practically nothing about diseases and parasites of Olividae, excepted for the mention that over 50% of adult *Olivella biplicata* are infested (and unsexed) by trematodes (EDWARDS, 1968), reducing their natality but not necessarily killing their hosts.

In contrast, we have many indications that other animals feed on Olividae (see GREIFENEDER, 1981). Generalised crypsis, nocturnal behaviour, occasional chemical defences and aposematism, (see VAN

OSSELAER *et al.*, 1993) as well as thick shells, tight coiling and short spires (see VERMEIJ, 1978: 35) all suggest that macropredators are by far the most likely candidates to explain massive mortality. In the case of the *O. oliva* population under study, this is furthermore supported by striking individual colour pattern variations. These have been linked in *Olivella* and *Donax* (SMITH, 1975) to protection against predation by oxypodid ghost crabs, abundant on Sisimangum Beach.

We cannot yet point to the most important predators, Hansa Bay harbouring a great variety of fish, starfish, crustaceans and other molluscs (predatory Gastropods and Cephalopods) liable to feed on *Oliva oliva*. The diversity of scar types observed on the shells suggests however that different predators are at work. The generally turbulent, sand-laded shallow waters of Sisimangum beach allow no direct study of predation on *O. oliva* at high tide. Predation by crabs has been occasionally noted on the beach at low tide, and successful attack by a stomatopod was observed in aquarium. Marks of drilling molluscs (Naticidae and Muricidae) or the characteristic bite of *Octopus* were observed on dead, but not on live shells, suggesting that attacks by these predators are generally successful. The impact of shorebirds (rather uncommon on Sisimangum Beach) and of man (possibly the most effective predator on *Olivella biplicata,* see STOHLER, 1969) is probably negligible here.

Most macro-predators fall roughly into two handy categories (for a more refined classification see VERMEIJ, 1978). "*Crunchers*" (for instance many crustaceans) aim at the shell and, if unsuccessful, often do leave traces of their attack (scars). By contrast, "*gulpers*" (for instance many species of fish) swallow their prey whole or reduce it to unrecognisable fragments, leaving neither corpse nor smoking gun to tell the story.

High pressure from "crunchers" has been evidenced (see § 3.1.6). On a black sand substrate one would expect "black" shells to be more protected than "white" shells. The distribution of scars amongst *O. oliva* shells shows exactly the contrary. This might appear surprising and deserves some comment. Similar situations have been studied (SMITH, 1975; VERMEIJ, 1978): the preferences of ocypodid ghost crabs and other predators for *Donax* and *Olivella* species. It has been shown that the crabs appear to form "search images", for either the most common or the most conspicuous prey, depending on prey density. In the present case, the "crunchers" favour the most abundant category of prey: "black" olives between 16 and 22 mm. It is known that such apostatic selection is effective in maintaining variability (see ALLEN, 1972). In this case it probably stabilises the balanced colour polymorphism observed in the *O. oliva* population at Sisimangum Beach.

Here again, the observed phenomenon is possibly not unique to Hansa Bay: a rather similar distribution of scars was noted by Dr. D. Greifeneder on the Balinese sample of *O. reticulata* mentioned above (§ 4.1). Scars were present on 25 % of specimens of intermediate sizes (the great majority of the sample) but were absent on shells smaller than 20 mm, as well as on thick-lipped, large shells.

The efficiency of "crunchers" is certainly limited, as most specimens of *O. oliva* have survived at least one attack from these predators. Most of the massive mortality is probably due to the "gulpers". This hypothesis is supported by the high proportion (72.1 %) of "black" shells on Sisimangum beach. It is likely to result from a trade-off between being the choice target of rather inefficient predators (the "crunchers") and being to some extent protected from effective killers (the "gulpers"). More work on the nature and the extent of predation is certainly needed.

4.3. Colour changes.

The observation of induced changes in shell colour adds one more dimension to the already remarkable possibilities of variation and adaptation displayed by *Oliva* species. It corroborates the "habitat chronicle" hypothesis of GREIFENEDER (1981b) (see § 3.2.1). It also casts further doubts on the use of shell colour in *Oliva* taxonomy, where this has traditionally been a predominant character.

It is unlikely that the substrate changes we have used to induce changes in shell coloration are the only (or even the main) cause for the colour shifts observed in natural conditions. From what we know of the sedentary habits of *Oliva*, such events are probably exceptional. Colour shifts often coincide with a large scar, suggesting they could be caused by physiological stress.

Why did "white" specimens not change colour when kept on black sand? This is probably due to the simple fact that they did not experience any change of substrate ("spontaneous" colour shifts must be very infrequent, judging from the material collected at Sisimangum). One could check this explanation by changing the substrate of "white" *Oliva,* living in white sand, to black sand. We

did not run this experiment in Hansa Bay, for fear of depleting the small "white" population of Boro Beach.

How *Oliva* do estimate the colour (or more probably the albedo) of the substrate, and how they effect their colour adaptation remains a mystery. It is noteworthy that 3 species of anomuran decapods (genus *Hippa*) share the beaches of Hansa Bay with *O. oliva* and likewise have a cryptic coloration. Experimental changes of substrate also induced colour changes in these species, after moulting on the new substrate (BAUCHAU & PASSELECQ-GERIN, 1987). There is no indication that the mechanism should be the same as in *Oliva*.

4.4. Growth rate.

The growth rate obtained from the experiments on induced colour shifts is roughly 4.0 mm/year (max: 7.5; min: 3.0) (for shells in the size range H=13 to 22 mm). This is compatible with the slow growths of less than 0.5 mm/month (less than 6 mm/ year) casually observed by us in aquarium for specimens of several *Oliva* species, including *O. oliva* (unpublished observations).

The only comparable data we know for Olividae concern the somewhat distantly related Californian *Olivella biplicata*. For this species that reaches 26-28 mm, very slow growth (between 0.7 and 3.2 mm/year) has been observed, and longevity was estimated at 8-12 years (STOHLER, 1969). There is a very great individual variation in the growth rate of *Olivella biplicata*: it varies from 0.1 to 5.1 mm/year within the same size class (15.5 to 16 mm).

4.5. Conclusions.

The size frequency distribution of *O. oliva* at Sisimangum Beach is very sharp and was stable over 8 months.

Young individuals between 14 and 22 mm constitute over 75% of the population. The chances for a specimen of *O. oliva* to reach "adult size" are very dim: only about 1% of the population reaches 38-42 mm.

Most specimens of *Oliva oliva* has survived at least one unsuccessful attack from a scar-leaving predator.

Maximum predation by scar-leaving predators corresponds to the most abundant category: "black" shells between 16 and 22 mm.

Changes in shell colour have been experimentally induced. When black specimens (from black sand) are kept on white sand, over 80% shift their shell colour to white.

The growth rate of *O. oliva* (at least in the size range H=13 to 22 mm) is roughly 4.0 mm/year (max: 7.5; min: 3.0). It follows that the age of an "adult" specimen is at least 10 years.

We do not know yet if the above observations are general or constitute a particular case, possibly reflecting local conditions. The observations of Dr. Greifeneder on *O. reticulata* in Bali do however suggest that the distributions observed here are not restricted to Hansa Bay or to *O. oliva*.

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The Lamarckian names for *Oliva* species
(Studies on Olividae. 23)

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SUMMARY. The nomenclatural status of the *Oliva* names introduced by Lamarck (1811 and 1822) has been re-examined. Of his 48 names, 11 have been retained as valid.

RESUME.Le statut nomenclatural des noms d' *Oliva* introduits par Lamarck (1811 et 1822) a été réexaminé. De ces 48 noms, 11 ont été retenus comme valides.

KEYWORDS. Mollusca, Gastropoda, Olividae, *Oliva*, nomenclature.

1. INTRODUCTION

This paper is the continuation of a previous work (TURSCH & al., 1994), in which all the Oliva names from Linnaeus to Perry were reviewed, in chronological order. We now have to deal with the Oliva names of Lamarck.

Jean-Baptiste Pierre Antoine de Monet, chevalier de la Marck (the name was prudently changed into "Lamarck" during the French Revolution) was born on August 1st, 1744 in Northern France. A short military career (during which he became fascinated by botany) was interrupted by an accident, and for a while Lamarck had to survive partly through trading in rare and valuable shells, a field in which he soon became an expert (DELAUNAY, 1994). Lamarck began his real scientific life as a botanist around 1778, and started a career in zoology only in 1793 (at the age of 50), when he was appointed as Professor of Zoology at the newly created Muséum d'Histoire Naturelle in Paris. Lamarck died on December 18, 1829.

It is unfair that today most people would link the name of Lamarck only with his theory of the heredity of acquired characters, now discredited. This was actually only a small part of the system of Lamarck. One of the most brilliant scientists of his time, a father of comparative anatomy and modern systematics, he was a pioneer of evolution, and probably the first to conceive an explicit phylogenetic tree of real organisms. His influence on biology is still deeply felt today. Lamarck was a scientific philosopher, concerned with a unifying theory in zoology. Although he described many species of Olives, it is unlikely that the genus *Oliva* was at the centre of his preoccupations.

Even before his appointment at the Muséum, Lamarck had already assembled a large collection of mollusc shells (at least fifty thousand specimens belonging to 13,288 species) and many of his descriptions are based upon his own material. Lamarck offered his collection to the French government for the sum of 30.000 livres but the offer was refused. After his death, the collection went to Prince Masséna who, in 1840, sold it to Baron Benjamin Delessert. It was later acquired by the Muséum d'Histoire Naturelle in Geneva (see DANCE, 1966). Most unfortunately, all of Lamarck's *Oliva* type material seem to have vanished and cannot be located anymore.

The absence of type specimens raises serious problems of identification because some species are based upon ambiguous illustrations. Worse, some species are not figured at all; Lamarck's indifference to illustrations is well known and has caused many problems of identity (see DANCE, 1966: 115). The problem is compounded by the fact that most species of *Oliva* differ by characters that are very difficult to describe in words. Very few *Oliva* species indeed can be unambiguously recognised from their original description, without referring to illustrations.

Nomenclatural stability has been our main concern. Many of Lamarck's familiar *Oliva* names (such as *irisans, mustelina, peruviana, undatella*) would have to be discarded as nomen dubium if judged exclusively on the merits of their original description. Fortunately these names are rescued by the magnificently illustrated work of Duclos, the first revisor of Lamarck. Duclos was a lifelong student and avid collector of *Oliva*, of which he possessed about fifteen thousand specimens. We can use

Duclos for interpreting Lamarck because one can prove that he was most familiar with the old master's *Oliva* collection, which he revised in detail. His conclusions were discussed with and approved by Lamarck himself. In DUCLOS (1845: 2), we find a moving account of this:

"... Lamarck venait de composer pour ce genre soixante-deux espèces à l'état vivant, et, malgré toutes les recherches que j'avais pu faire pour me les procurer, je n'étais parvenu qu'à un nombre bien moindre, et qui ne dépassait pas quarante. Je dus en augurer que celles qui me manquaient pouvaient bien n'être pas réelles et ne constituer que de simples variétés: il fallait donc de toute nécéssité recourir à la collection de ce professeur, car c'est uniquement sur elle qu'il établi son système; il n'emprunta presque rien à celle du Muséum. Mais, à cette époque, il était déjà complètement aveugle. Cependant, il m'autorisa à faire cette vérification, en me témoignant le désir qu'elle fut faite devant lui, et, au fur et à mesure que mes prévisions se justifiaient, qu'une espèce, qui m'avait tant fait courrir pour la posséder, n'était qu'une simple variété d'une autre qui me paraissait devoir en être le type, il demandait à la tenir, et sous ses doigts, aussi clairvoyants qu' investigateurs, il reconnaissait, à l'aide de mes observations, que je disais la vérité, et que c'était lui qui s'était trompé; car il est bon qu'on sache que, lorsqu'il décrivit son genre Olive, ses yeux étaient déjà trop faibles pour qu'il parvint à les distinguer les unes des autres. Ce qui le frappa le plus dans mes remarques, ce fut son Olive harpulaire, qui ne différait de la réticulaire que par des signes d'accroissement plus prononcés, signes que l'on retrouva dans toutes les autres espèces. Il manifesta en termes sévères les regrets qu'il éprouvait d'avoir été si mal entouré. Ma rectification réduisit le nombre de ses espèces à quarante-deux; c'était un tiers de moins. Tout autre homme aurait pu montrer un peu d'humeur; mais lui, si juste en toutes choses, si passionné pour le progrès de la science, loin de se plaindre, ne vit dans cette réduction qu'une chose utile, indispensable; et ce fut lui qui me contraignit de faire à ce sujet un mémoire à l'Académie des sciences, m'assurant, disait-il, qu'il se placerait près de moi quand je le lirais, pour affirmer à ses collègues que ce que j' annonçais était contrôlé par lui. ...."

Duclos can certainly not be suspected of being biased against Lamarck. On the title page of Duclos (1835) he introduces himself (in large, bold font) as "*élève de Lamarck*". The work itself is dedicated "*A la mémoire de Lamarck, créateur de la science conchyliologique, hommage de vénération et de profond respect de son élève J.P. Duclos*". It is therefore quite safe to refer to the opinion of Duclos to establish the identity of the non-illustrated taxa, for which Lamarck's descriptions are insufficient. Most of the type specimens of Duclos are still preserved at the Muséum d'Histoire Naturelle in Paris and the bulk of his collection is in the Museum of Clermont-Ferrand, France. The identity of most of the species of Duclos is thus quite secure. For the dates of the publications of DUCLOS (often erroneously quoted), see SHERBORN & SMITH, (1911). References will be made here to DUCLOS (1844-48), containing all the illustrations of DUCLOS (1835-40) with, in addition, a good descriptive text.

After a definition of the genus *Oliva* (LAMARCK, 1801), most of Lamark's *Oliva* species were published in LAMARCK (1811), often referring to illustrations in the Plates 361 to 368 of LAMARCK (1798), the *Tableau Encyclopédique et Méthodique des trois règnes de la Nature*, here after referred to as "Encycl". (for dates of publication, see SHERBORN & WOODWARD, 1906). Exactly the same descriptions appear in LAMARCK (1817). Some new species are described in LAMARCK (1822). The second and the third edition of Lamarck's *Histoire Naturelle des Animaux sans vertèbres* were edited by Deshayes in collaboration with Milne-Edwards (see IREDALE, 1922).

2. THE SPECIES.

Three categories of names have not been considered here:

a. Names given by previous authors. These are: *carneola* (sp. n° 39), *ispidula* (sp. n° 40), *porphyria* (sp. n° 1). These names have been reviewed in TURSCH & *al.* (1994).

b. Names refering to species that are not in the genus *Oliva*. These are *acuminata* (sp. n° 48), *auricularia* (sp. n° 47), *brasiliana* (sp. n° 45), *conoidalis* (sp. n° 54), *eburnea* (sp. n° 56), *hiatula* (sp. n° 52), *luteola* (sp. n° 50), *nana* (sp. n° 57), *oryza* (sp. n° 59), *subulata* (sp. n° 49), *testacea* (sp. n° 51), *utriculus* (sp. n° 46), *volutella* (sp. n° 43), *zonalis* (sp. n° 58).

c. Names refering to fossil species.

Names are reviewed in alphabetical order, for the facility of the reader. Some frequent misspellings and misquotations of Lamarck have been included in this list.

Detailed discussion of the original decriptions is not given for objective junior synonyms, where in any case no alternative taxonomic status is possible. In all other cases, in order to allow verification of our conclusions, the original description is given

verbatim, save for formatting of the text (here much compacted for the sake of space economy).

To avoid confusion, figures will be written "figs." when referring to illustrations in other works and "FIGS." when referring to illustrations in the present paper. The frequently used abbreviation "*q.v.*" (*quod vide*) means "refer to".

"*alba* Lamarck" in Gray, 1858 (*Proc. Zool. Soc.* Lond. 26: 44).

This is cited by GRAY (1858) as a synonym of *Strephona reticularis* Lamarck (Gray's sp. 12). *O. alba* Lamarck does not exist. Gray refers to sp. 42 of Lamarck, 1811, *candida*, for which "*alba*" is part of the Latin description (see BURCH & BURCH, 1960). This is a **misquotation**.

***angulata* Lamarck, 1811** (*Ann. Mus.* 16: 310, sp. n° 6).

DISCUSSION. The figures in Encycl. (Pl. 363, figs. 6a, 6b) very clearly depict *O. incrassata* (Lightfoot, 1786). This is confirmed by the description of DUCLOS (1845, text p.20 and 1840, Pl. 18, figs. 9, 10). Lamarck's reference to Martini's figs 499 and 500 (MARTINI, 1769), already used for establishing *incrassata* (Lightfoot, 1786) (see TURSCH & *al.*, 1994) makes it an **objective junior synonym** of *O. incrassata* (Lightfoot, 1786). This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969) and WAGNER & ABBOTT (1978).

***araneosa* Lamarck, 1811** (*Ann. Mus.* 16: 315, sp. n° 19).

DISCUSSION. The figures in Encycl. (Pl. 363, figs. 1a, 1b) possibly depict *O. spicata* (Röding, 1798) but more probably *O. reticularis* Lamarck, 1811. This is confirmed by DUCLOS (1845, text p.16) placing *O. araneosa* Lamarck in the synonymy of *O. reticularis* Lamarck. In any case, Lamarck's reference to Martini's figs 509 and 510 (MARTINI, 1769), already used for establishing *O. spicata* (Röding, 1798) (see TURSCH & *al.*, 1994) makes it an **objective junior synonym** of *O. spicata* (Röding, 1798). This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT, (1986).

***avellana* Lamarck, 1811** (*Ann. Mus.* 16: 320, sp. n° 37).

ORIGINAL DESCRIPTION: 37. Olive aveline. *Oliva avellana. O. Cylindrica, fulva, undis minimis vix perspicuis reticulata; spirâ retusâ.* Mus. n. 67. Mon Cabinet. Habite ... L' olive aveline paroît avoir de grands rapports avec l'olive glandiforme (*O. glandiformis*, p. 317, sp. 27, remark ours). Mais elle est plus cylindrique, moins bombée, et semble unicolore. Elle est rousse ou d'un fauve sale et roussâtre; ses ondes menues et en zigzag ne s'aperçoivent presque point. Sa spire est très-obtuse. Longueur, 35 millimètres.

LAMARCK (1822: 430, sp. n° 37) corrects "*fulva*" to "*fulvo-rubente*" and adds "*ore albido*". Also : "ses ondes menues et en zigzag, et sa spire rétuse, la rendent très remarquable".

DISCUSSION. There is no illustration of this taxon. The description could apply to many small *Oliva* species and furthermore suggests a sun-burned shell , and the name *avellana* is indeed often applied today to all kinds of small reddish beach specimens. These doubts are confirmed by the description of DUCLOS (1845, text p. 26 and Pl. 30, figs. 1-3 and figs. 13, 14), depicting at least 3 different species. We see no way of identifying *O. avellana* and consider it as a **nomen dubium**. This taxon is considered valid for ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT, (1986).

"*O. avellana* Lamarck,1811" is illustrated in ZEIGLER & PORRECA (1969, Pl. 13, fig. 11) by a common variation of *O. bulbiformis* Duclos, 1840 and in PETUCH & SARGENT, (1986, Pl. 4, figs. 1, 2) by a very pale shell with a reddish-brown aperture, bearing little resemblance with Lamarck's description (in particular: *ore albido*).

***bicincta* Lamarck, 1822** (*Hist. Nat.* 7: 429, sp. n° 33).

DISCUSSION. In the description, Lamarck refers to the illustrations in Encycl. (Pl. 364, figs. 1a, 1b) already used for *O. bicingulata* Lamarck, 1811 (*q.v.*), which is also cited in the synonymy. This makes *O. bicincta* Lamarck an **objective junior synonym** of *O. bicingulata* Lamarck, 1811. This is in agreement with WAGNER & ABBOTT (1978). DUCLOS (1845: 27) considers *O. bicincta* Lamarck (together with *O. bicingulata* Lamarck) as his variety 2 ("Avec deux fascies") of *O. inflata* Lamarck, 1811, the old name for *O. bulbosa* (Röding, 1798). It is *O. bulbosa* (Röding, 1798) for

BURCH & BURCH (1960) and PETUCH & SARGENT, (1986).

***bicingulata* Lamarck, 1811** (*Ann. Mus.* 16: 319, sp. n° 33).

ORIGINAL DESCRIPTION: 33. Olive à deux bandes. *Oliva bicingulata. O. Ovata, ventricosa, alba, pallidè punctata ; fasciis duabus transversis fusco-fulvis ; columellâ tuberculatâ.* Mus., n. 55. Encycl. pl. 364, f. 1. Habite ... Cette espèce est bien distincte des deux précédentes (*undata*, sp. n° 31, and *inflata*, sp. n° 32, remark ours) et cependant elle leur ressemble par sa forme générale, par sa spire courte et mucronée, enfin par les tubercules comprimés de sa columelle. Celle-ci est blanche, parsemée de points ou de gouttelettes d'un gris bleuâtre, et offre deux bandes transverses, brunes ou couleur de rouille. L'ouverture est blanche, quelquefois d'une couleur enfumée ou de chair livide. Longueur, 34 à 35 millimètres.

DISCUSSION. The figures in Encycl. (Pl. 364, figs 1a,1b) (see FIGS. 1, 2) and the description unmistakably depict *O. bulbosa* (Röding, 1798). This is confirmed by DUCLOS (1845: 27) who considers *O. bicingulata* Lamarck as a form ("2. Var. *Avec deux fascies*") of *O. inflata* Lamarck, 1811, the old name for *O. bulbosa* (Röding, 1798). *O. bicingulata* Lamarck, 1811 is a **subjective junior synonym (colour form)** of *O. bulbosa* (Röding, 1798). This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT, (1986).

***candida* Lamarck, 1811** (*Ann. Mus.* 16: 322, sp. n° 42).

ORIGINAL DESCRIPTION: 42. Olive blanche. *Oliva candida. O. Ovato-cylindracea, alba, immaculata; spirâ subacutâ; costellis columellae remotiusculis.* Mus., n.31. Encycl., pl. 368, f. 4. β. Var. couleur de soufre. Habite ... Une olive non fossile, toute blanche et sans taches quelconques, présente une particularité peu commune dans ce genre; et c'est le cas de l'espèce dont il est ici question, qui est caractérisée d'ailleurs par sa forme particulière. Sa longueur est de 33 ou 34 millimètres. Le bord supérieur de ses tours de spire est un peu marginé. Elle se rapproche par sa columelle de l'olive réticulaire (*O. reticularis* Lamarck, remark ours).

In LAMARCK (1822: 432, sp. n° 42) one finds a variant: "*plicis columellae remotiusculis*" ... [b] *Var. testâ pallidè citrinâ.* Mon cabinet. ..... Habite ... Mon cabinet. La forme de celle-ci présente un léger renflement qui n'a point lieu dans les deux précédentes (*O. oriola* Lamarck, 1811, sp. n° 41, and *O. ispidula* Lamarck, 1811, sp. n° 40, remark ours); et quant à sa coloration, elle est toute blanche, immaculée, sans être néanmoins fossile. Longueur, 15 lignes trois quarts.

DISCUSSION. The figures in Encycl. (Pl. 368, figs. 4a, 4b) (see FIGS. 3,4) could equally well represent a fat *O. oliva* (Linnaeus, 1758) or some other shell, for instance an *O. amethystina* (Röding, 1798) without colour marks or the white Bahamas form of *O. reticularis* Lamarck, 1811. DUCLOS (1845: 16) cites *O. candida* Lamarck in the synonymy of *O. reticularis* Lamarck. The name *candida* Lamarck is often used to designate white shells of the "*O. oliva* complex" (TURSCH, MISSA & BOUILLON, 1992). It cannot be identified with any certainty and is a **nomen dubium**. This taxon has been considered as being *ispidula* (L.) by BURCH & BURCH (1960), a form of *O. oliva* by ZEIGLER & PORRECA (1969) and a colour form of *O. taeniata* Link, 1807 by PETUCH & SARGENT (1986). BURCH & BURCH (1967) doubt it is *O. oliva*.

***"cruentata* Lamarck"** (auct.).

This is a frequent **misquotation**. There is no *cruentata* in Lamarck. There is a *O. cruenta* described (p.612, sp. n° 14) in the 1844 reedition of the "Histoire Naturelle des Animaux sans Vertèbres ... par J.B.P.A. de Lamarck, ... revue et augmentée par G.P. Deshayes et H. Milne Edwards", who should be credited with the authorship of the name because Lamarck died in 1829. It is a junior homonym of *O. cruenta* Dillwyn, 1817. "*O. cruentata* Lamarck" is cited as a synonym of *O. annulata* (Gmelin, 1791) by BURCH & BURCH (1960), ZEIGLER & ABBOTT (1978).

***decorticata* Lamarck, 1811** (*Ann. Mus.* 16: 319, sp. 34, var.)

DISCUSSION. The name *O. decorticata* is cited in the description of *Oliva harpularia* Lamarck, 1811 (*q.v.*) in the following terms: "La même dépouillée (*decorticata*) offrant des lignes longitudinales d'un rouge-brun, et un peu en zigzag. Mon Cabinet. Chemn. Conch. 10, t.147, f. 1376 et 1377." This name is no longer used in LAMARCK (1822: 429, sp. n° 34). As *O. harpularia* Lamarck is a nomen dubium, this must also be a **nomen dubium**.

***dombeyana* Lamarck, 1811** (*Ann. Mus.* 16: 318, sp. n° 28, var. β).

DISCUSSION. The name *O. dombeyana* is cited in the description of *Oliva peruviana*

Lamarck, 1811 (*q.v.*) in the following terms: "β. La même plus colorée, plus rembrunie. *O. Dombeyana*. Habite les côtes du Pérou, d'où elle fut rapportée par *Dombey*. Cette olive constitue une espèce distincte, par sa forme particulière et ses couleurs". One will notice the apparent discrepancy (for modern biologists) between "*la même*" and "*espèce distincte*". This name is no longer used in LAMARCK (1822: 427, sp. n° 28) and can only designate a **colour form** of *O. peruviana* Lamarck, 1811.

***elegans* Lamarck, 1811** (*Ann. Mus.* 16: 312, sp. n° 11).

ORIGINAL DESCRIPTION: 11. Olive élégante. *Oliva elegans. O. Cylindracea, albida; lineis fuscis, subpunctatis, flexuoso-angulatis; spirâ retusâ mucronatâ.* Mus., n. 19. Encycl., pl. 367, f. 3. β. Var. à deux zônes transverses. Encycl., pl. 362; f.3. List. Conch., t. 728, f. 15. Habite ... La coquille [α], très-bien représentée dans l'Encyclopédie, offre sur un fond blanchâtre des lignes de points bruns nombreuses, en grands zigzags presque transverses, et qui la rendent très-remarquable. L'ouverture est blanche, un peu teinte de couleur de chair au bas de la columelle. La spire est aplatie, mucronée. La variété β a ses lignes plus interrompues, le fonds plus coloré, et offre deux zônes brunes plus ou moins complètes. La longueur de cette espèce est de 40 à 46 millimètres.

DISCUSSION. The figures in Encycl. (Pl. 367, figs. 3a, 3b) (see FIGS. 5, 6) are ambiguous and might possibly depict *O. tigrina* Lamarck, 1811 (*q.v.*). The other figures in Encycl., (Pl. 362; figs. 3a, 3b) (see FIGS. 7, 8) and that of LISTER (1682-95, Conch., t. 728, fig. 15) are quite compatible with the present, unanimous concept of *O. elegans*. The description in DUCLOS (1845: 24) and his clear illustrations (1840, Pl. 21, figs. 1-6 and 1840, Pl. 32, figs. 1-3) confirm the identity of *O. elegans* Lamarck, a **valid species**. This is in agreement with BURCH & BURCH (1967), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT, (1986).

***episcopalis* Lamarck, 1811** (*Ann. Mus.* 16: 313, sp. n° 12)

ORIGINAL DESCRIPTION: 12. Olive épiscopale. *Oliva episcopalis. O. Cylindracea, albida, punctis fusco-luteis nebulatâ; ore violaceo.* Mus. n. 10. List. Conch., t. 719, f. 3. Gualt. ind., t. 23, fig. F.T. Habite ... L'olive épiscopale est une espèce constamment distincte par la couleur d'un beau violet qui s'offre à son ouverture. Elle est blanche, mouchetée de points bruns mêlés d'un peu de jaune ou d'orangé. Sa spire est convexe, terminée en pointe. Sa longueur est de 48 millimètres.

DISCUSSION. The cited figure of LISTER (1682-95, with the indication "*labro ... purpurascente*"), the description and the size leave no doubt on the identity of this shell. This taxon is furthermore very clearly illustrated by DUCLOS (1835, Pl. 10, figs. 11, 12). *O. episcopalis* Lamarck is a **subjective junior synonym** of *O. caerulea* (Röding, 1798). This is in agreement with WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).The species was considered valid by ZEIGLER & PORRECA (1969).

***erythrostoma* Lamarck, 1811** (*Ann. Mus.* 16: 309, sp. n° 3).

DISCUSSION. The description and the good illustration in Encycl. (Pl. 361, fig. 3) leave no doubt about the identity of this taxon. This is further confirmed by DUCLOS (1845:18). Lamarck cites the figures 476 and 477 of MARTINI (1769), previously utilised to establish *O. miniacea* (Röding, 1798) (see TURSCH & *al.*, 1994). This makes *O. erythrostoma* Lamarck an **objective junior synonym** of *O. miniacea* (Röding, 1798). This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***fabagina* Lamarck, 1811** (*Ann. Mus.* 16: 325, sp. n° 53).

ORIGINAL DESCRIPTION: 53. Olive féverolle. *Oliva fabagina. O.Brevis, ovata, albo fuscoque vel furvo variegatâ ; spirâ brevi acutâ.* Encycl., pl. 363, f. 5. Martini, Conch. 2, t. 49, f. 532, 533. Habite ... Il n'y a point de doute que cette olive ne soit une espèce très-distincte de celles que l' on connoît, tant sa forme est particulière. Elle est singulièrement courte, relativement à sa largeur.

DISCUSSION. LAMARCK (1822: 437, sp. n° 56) gives no further information. Martini's fig. 533 has been previously used for *O. reticulata* (Röding, 1798) but is unidentifiable (see TURSCH & *al.*, 1994). Martini's fig. 532 and the figures in Encycl. (Pl. 363, figs. 5a,5b) (see FIGS. 9, 10) depict a shell that is rather difformed but compatible with *O. bulbosa* (Röding, 1798). This is confimed by DUCLOS (1845, pp. 26, 27) who considers *O. fabagina* Lamarck as his variety 6 ("*Flammulée avec fascies*") of *O. inflata* Lamarck, a name formerly used for *O. bulbosa* (Röding, 1798). *O. fabagina* Lamarck is a **subjective junior**

synonym (maybe a form) of *O. bulbosa* (Röding, 1798). This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***flammulata* Lamarck, 1811** (*Ann. Mus.* 16: 314, sp. n° 17).

ORIGINAL DESCRIPTION: 17. Olive flammulée. *Oliva flammulata. O. Cylindracea, lineis fulvis et angulatis undata; maculis albis, trigono-acutis, transversis, inaequalibus ; spirâ acutâ.* Mus., n. 13. Encycl., pl. 367, f. 3. Martini Conch. 2, t. 49, f. 526. Habite ... Cette espèce n' acquiert qu'une taille médiocre. Elle est cylindracée, peu ventrue, d'un gris roussâtre, nuée de linéoles anguleuses, d'un roux brun, et ornée de flammules ou taches blanches, trigones aigües, et inégales, qui la rendent remarquable. Sa spire est pointue; sa longueur est de 3 centimètres.

DISCUSSION. LAMARCK (1822: 424, sp. n° 17) corrects the obvious missprint "Encycl., pl. 367, f. 3" (previously utilised for *O. elegans*) into "Encycl., pl. 367, f. 5". Both the description and the clear illustration in Encycl. (Pl. 367, fig. 5) (see FIG. 11) as well as Martini's figure 526 (MARTINI, 1769) agree with the present, unanimous concept of this species. This is confirmed by the description of DUCLOS (1844: 14) and his very clear illustrations of this variable shell (1835, Pl. 8, figs. 17-20) and even of the live animal (Pl. 32, figs. 3, 4). *O. flammulata* Lamarck is **valid**, in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***fulminans* Lamarck, 1811** (*Ann. Mus.* 16: 312, sp. n° 9).

ORIGINAL DESCRIPTION: 9. Olive foudroyante. *Oliva fulminans. O. Cylindracea, apice retusa, cinereo-viridescens ; lineis longitudinalibus flexuoso-angulatis fuscis ; ore candido.* Mus., n. 8. Encycl., pl. 364, f. 4. Chemn. Conch. 10, t. 147, f. 1374. Habite ... Cette olive remarquable par ses lignes brunes, longitudinales et en zigzag, sur un fond d'un cendré verdâtre, se rapproche néanmoins des deux précédentes (*O. sepulturalis* Lamarck, 1811, sp. n° 8 and *O. maura* Lamarck, 1811, sp. n° 7, remark ours) par sa forme et sa spire très-courte; néanmoins les collections consultées, montrent qu'elle en est constamment distincte. Sa longueur est de 53 millimètres : elle n'est pas commune.

LAMARCK (1822: 421, sp. n° 9) has the same description in Latin but much shorter in French: "Habite .... Mon cabinet. Spire très-rétuse; callosité du sommet de la columelle un peu forte et saillante. Longueur, 23 lignes".

DISCUSSION. The figure 1374 of CHEMNITZ (1786) is compatible with *O. nigrita* (Karsten, 1789), of which *O. vidua* (Röding, 1798) is an objective junior synonym (see TURSCH & *al.*, 1994) and the figures in Encycl. (Pl. 364, figs. 4a, 4b) (see FIGS. 12, 13) are compatible with this species. This is confirmed by DUCLOS (1845: 27) who considers *O. fulminans* Lamarck as his variety δ ("*zébrée ou foudroyée*") of *O. maura* Lamarck, 1811 (a name formerly used for *O. nigrita*). *O. fulminans* Lamarck is thus a **colour form** of *O. nigrita* (Karsten, 1789). It is a form of *O. vidua* (Röding, 1798), another name formerly used for *O. nigrita* for ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986), *O. oliva* (L.). -a name used at the time for *O. nigrita* (Karsten, 1789)- for BURCH & BURCH (1960).

***funebralis* Lamarck, 1811** (*Ann. Mus.* 16: 317, sp. n° 26).

ORIGINAL DESCRIPTION: 26. Olive funébrale. *Oliva funebralis. O. Cylindracea, flavida; maculis olivaceo-fuscis; spirâ brevi; ore albido. Oliva leucostoma.* Mus., n. 23. Encycl., pl. 365, f. 3 ? Martini Conch. 2, t. 45, f. 480, 481. Habite l' Océan des grandes Indes. Par ses taches, cette olive a quelques rapports avec la précédente (*O. lugubris*, remark ours). Mais ces taches sont disposées sur un fond jaune ou jaunâtre, et présentent de grandes masses d'un brun verdâtre. La spire est très-courte, mucronée; la columelle est blanche, et le fond de l'ouverture est blanchâtre, ou un peu enfumé. Longueur, environ 35 millimètres.

DISCUSSION. LAMARCK (1822: 427, sp. n° 26) does not give further information and does not mention anymore *O. leucostoma* Lamarck, 1811 (*q.v.*). Martini's figures 480 and 481 (MARTINI, 1769) have both been previously used for establishing both *O. variegata* (Röding, 1798), a nomen nudum, and *O. sepultura-principis* (Röding, 1798), another nomen nudum (see TURSCH & *al.*, 1994). The figure in Encycl. (Pl. 365, fig. 3), refered to with a question mark (see FIG. 14) does not help, as it has been used by LAMARCK himself for another taxon, *O. maura* var. δ Lamarck, 1811 (*q.v.*), a junior synonym of *O. nigrita* (Karsten, 1789). DUCLOS (1840: 27) considers *O. fulminans* Lamarck as his variety 5 ("*ponctuée avec trois fascies*") of *O. maura* (now *O. nigrita*). The meaning of *O. fulminans* Lamarck, of which *O. leucostoma* Lamarck (q.v.) is necessarily an objective

synonym, is not clear, as the described characters are often found in varieties of *O. nigrita*. It is wiser to consider it as a **nomen dubium**. It is also a doubtful species for BURCH & BURCH (1967). It is a valid species for ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

O. funebralis ; Tryon (not Lamarck, 1811), 1883 is *O dactyliola* Duclos (BURCH & BURCH, 1960) according to WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***fusiformis* Lamarck, 1811** (*Ann. Mus.* 16: 318, sp. n° 30).

ORIGINAL DESCRIPTION: 30. Olive fusiforme. *Oliva fusiformis. O. Ventricosa, utrinquè attenuata, alba ; lineis fulvis, undatim flexuosis; spirâ acutâ.* Mus., n.35. Encycl., pl. 367, f. 1. Seba, Mus., 111, t. 53, fig. R. Martini, Conch. 2, t. 51, f. 562 ? Habite ... Cette olive paroit avoir des rapports avec l'olive du Pérou, n 28 ; mais elle en est très-distincte par sa spire élevée et pointue. Sur un fond de blanc de lait très-brillant, elle est ornée de lignes rousses ondées ou en zigzag, qui lui donnent un aspect agréable. On ne peut confondre cette espèce avec aucune de celles qui sont connues. Longueur, 48 millimètres.

DISCUSSION. The description refers to figures in Encycl. (Pl. 367, figs. 1a, 1b) (see Figs. 15, 16) and to SEBA (1734-65: fig. R), both clearly depicting *O. fulgurator* (Röding, 1798). The description and illustrations of *O. fusiformis* Lamarck in DUCLOS 1845 (p.26, Pl. 17, figs. 12-16 and Pl. 36, figs. 15, 16) also clearly refer to *O. fulgurator* (Röding, 1798). If it were not for the question mark following Lamarck's reference to Martini's figure 562, which was previously used for establishing *O. fulgurator* (Röding, 1798) (see TURSCH & *al.*, 1994), *O. fusiformis* Lamarck would be an objective junior synonym of *O. fulgurator* (Röding, 1798). It is in all cases a **subjective junior synonym** of that species. This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

"O. *gibbosa* Lamarck" (auct.).

Misquotation. This is not in Lamarck, is not an *Oliva*, but refers to *Olivancillaria gibbosa* (Born, 1778) (Mus. Caes. Vind.: 202). This is *O. bulbosa* (Röding, 1798) for BURCH & BURCH, (1960).

***glandiformis* Lamarck, 1811** (*Ann. Mus.* 16: 317, sp. n° 27).

ORIGINAL DESCRIPTION: 27. Olive glandiforme. *Oliva glandiformis. O. Ovato-cylindracea, maculis exiguis fusco-rubiginosis tessellata; spirâ retusâ; ore alo.* Mus., n. 20. Mon Cabinet. β. Var. rougeâtre, ornée de lignes purpurines en zigzag. Girol. Adans. Seneg., pl 4, f. 6. Habite ... probablement les mers de l'Amérique méridionale. Cette olive ressemble assez, par la forme et la taille, à un gros gland; elle est ovale cylindracée, un peu bombée, et a sa spire très-courte, rétuse, un peu mucronée. Elle est finement marquetée de rouge-brun ou de couleur de rouille sur un fond blanchâtre; quelquefois les mailles de son réseau forment des ondes en zigzags. Cette coquille est peu commune; sa longueur est de 39 millimètres. La variété β est moins ventrue, et un peu plus petite; elle se trouve au Sénégal; on pourroit la distinguer.

DISCUSSION. No furher information is given in LAMARCK (1822: 427, sp. n° 27). This taxon is not mentionned in DUCLOS and, being impossible to identify is a **nomen dubium**. This is in agreement with BURCH & BURCH (1960), BURCH & BURCH (1967), WAGNER & ABBOTT (1978).

***granitella* Lamarck, 1811** (*Ann. Mus.* 16: 314, sp. n° 18).

ORIGINAL DESCRIPTION: 18. Olive granitelle. *Oliva granitella. O. Castaneo-fulva, maculis albis trigonis minimis et creberrimis picta; ore albo.* Mon Cabinet. β. Var. ondée, et moins tachetée. Habite ... Cette olive devient assez grande, et semble, par ses rapports, tenir le milieu entre l'espèce précédente et celle qui suit (*flammulata* and *araneosa*, remark ours). Elle est cylindracée, d'un marron roussâtre, et ornée d'une multitude de très-petites taches blanches et trigones. Elle est blanche à son ouverture. La longueur des plus grands individus est de 64 millimètres. LAMARCK (1822: 424, sp. n° 18) adds to the Latin description: "*spirâ brevissimà, mucronatà*".

DISCUSSION. This species is not identifiable from the description. According to DUCLOS (1845: 18) it is *O. textilina* Lamarck (which is compatible with the original description). *O. textilina* Lamarck (*q.v.*) being a objective junior synonym of *O. sericea* (Röding, 1798), it follows that *O. granitella* Lamarck is a **subjective junior synonym** of *O. sericea* (Röding, 1798). This is in agreement with BURCH & BURCH (1960), BURCH & BURCH (1967), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***guttata Lamarck*, 1811** (*Ann. Mus.* 16: 313, sp. n° 14).

DISCUSSION. This case has already been studied in detail in TURSCH, GERMAIN & GREIFENEDER (1986) and it was concluded that it is a subspecies (possibly local form) of *O. amethystina* (Röding, 1798). This is in agreement with the description of DUCLOS (1845: 19). In any case, the name is preoccupied by *guttata* Fischer, 1807, itself a junior synonym of *O. olivacea* Karsten, 1789 (see TURSCH & *al.*, 1994). *O. guttata* Lamarck is a **junior homonym** of *O. guttata* Fischer, 1807. According to BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986), *O. guttata* Lamarck is *O. annulata* (Gmelin, 1791) (a nomen dubium, see TURSCH, GERMAIN & GREIFENEDER, 1986)

***harpularia* Lamarck, 1811** (*Ann. Mus.* 16: 319, sp. n° 34).

ORIGINAL DESCRIPTION: 34. Olive harpulaire. *Oliva harpularia. O. Cylindracea, fulva aut spadicea, bifasciata; costellis longitudinalibus obsoletis; maculis trigonis exiguis.* Mon Cabinet. Encycl. pl. 365, fig. 4 ? *La même dépouillée (*decorticata*) offrant des lignes longitudinales d'un rouge-brun, et un peu en zigzag. Mon Cabinet. Chemn. Conch. 10, t. 147, f. 1376 et 1377. Habite ... C'est avec l'olive réticulaire, n. 15, que cette espèce paroît avoir quelques rapports; mais elle est très-distinguée par ses couleurs, et par les espèces de petites côtes longitudinales qu'on aperçoit sans les sentir. Elle est d'un roux brun ou d'un brun rougeâtre, ornée de deux bandes transversales, et de très-petites taches trigones et blanchâtres. La spire est un peu pointue. Longueur, 46 millimètres.

DISCUSSION. There is no further information in LAMARCK (1822: 429, sp. n° 34). The figure in Encycl. (Pl. 365, fig. 4), cited with a question mark, is used by LAMARCK himself for establishing *O. tricolor* Lamarck. Figures 1376 and 1377 of CHEMNITZ (1786) could represent many large American olives. DUCLOS (1845: 16) places *O. harpularia* Lamarck, 1811 in the synonymy of *O. reticularis* Lamarck, 1811. It is obviously best to consider this taxon (probably a very worn specimen of a large American olive) as a **nomen dubium**. This is *O. spicata* (Röding, 1798) for BURCH & BURCH (1960) and WAGNER & ABBOTT (1978), a colour form of *O. venulata* Lamarck, 1811 for PETUCH & SARGENT (1986).

***hepatica* Lamarck, 1811** (*Ann.Mus.* 16: 320., sp. n° 35).

ORIGINAL DESCRIPTION: 35. Olive hépatique. *Oliva hepatica. O. Cylindracea, elongata, subcastanea; spirâ convexo-acutâ, variegatâ; ore albo.* Mus., n. 29. Mon Cabinet. Habite ... Cette olive est cylindracée, allongée, d'un brun marron, presque sans aucune tache. La spire est médiocre, convexe, un peu pointue, panachée de blanc et de marron. La columelle est striée transversalement dans toute sa longueur. Cette coquille est longue de 53 millimètres.

In LAMARCK (1822: 430, sp. n° 35) one finds the Latin description: "*O. testâ cylindraceâ, elongatâ, castaneo-fuscescente, obscurè zonatâ; spirâ convexo-acutâ, variegatâ; ore albo*". The French descriptions is nearly the same, but ends with: "Columelle striée transversalement dans toute sa longueur, et d'un beau blanc, ainsi que le bord droit".

DISCUSSION. According to DUCLOS (1845: 17) this is *O. tremulina* Lamarck, 1811. The description could apply to the dark colour forms of *O. tremulina* Lamarck, 1811, *O. concinna* Marrat, 1870 or even *O. ornata* Marrat, 1867. We therefore prefer to consider *O. hepatica* Lamarck, 1811 a **nomen dubium**. This is *O. tremulina* Lamarck for BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***inflata* Lamarck, 1811** (*Ann.Mus.* 16: 319, sp. n° 32).

ORIGINAL DESCRIPTION: 32. Olive enflée. *Oliva inflata. O. Ovata, ventricosa, albido lutescens, fusco-punctata; spirâ brevi mucronatâ; columellâ callis tuberculatâ.* Mus., n. 53. Encycl., pl. 364, f. 5. Habite ... Cette olive ressemble assez à la précédente (*O. undata* Lamarck, 1811, remark ours) par les callosités tuberculeuses de sa columelle, et même par sa forme ovale un peu ventrue; mais elle est colorée différemment, et sa spire, quoique très-courte, est plus éminemment mucronée. Sur un fond d'un blanc jaunâtre, elle présente un multitude de points bruns, nébuleux d'un côté, et épars. Longueur, 39 millimètres.

DISCUSSION. From the description, the figures in Encycl. (Pl. 364, figs. 5a, 5b) (see FIGS. 17, 18) and the account of DUCLOS (1845: 26) there can be no doubt that *O. inflata* Lamarck is a **subjective junior synonym** of *O. bulbosa* (Röding, 1798). This is in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***irisans* Lamarck, 1811** (*Ann. Mus.* 16: 312, sp. n° 10).

ORIGINAL DESCRIPTION: 10. Olive irisante. *Oliva irisans. O. Cylindraca, bifasciata, lineis flexuosis fusco luteis subreticulata; spirâ acuminatâ; columellâ basi subcarneâ.* Mus. n. 9. Mon Cabinet. Martini Conch. 2, t. 561. *An* Chemn. Conch. 10, t. 147, f. 1371-1372 ? Habite ... Cette olive est élégamment ornée de lignes en zigzag, serrées, brunes et bordées d'un jaune orangé, disposées sur un fond blanchâtre. Deux zones réticulées et un peu rembrunies la traversent. L'ouverture est blanche, mais la base de la columelle est teinte de couleur chair. Longueur, 5 centimètres.

DISCUSSION. There is no further information in LAMARCK (1822: 422, sp. n° 10). The figure 561 of Martini is unrecognizable. The figures of CHEMNITZ (1786: figs. 1371-2) (cited with a question mark) most probably depicts the *zigzag* form of *O. reticulata* (Röding, 1798). *O. irisans* Lamarck, 1811 can hardly been recognized by the original description and has been a most controversial species. It is a nomen nudum for BURCH & BURCH (1960), indeterminate for WAGNER & ABBOTT (1978), valid for PETUCH & SARGENT (1986). Much of the controversy might be explained by the comment of DUCLOS (1845: 30): "*Coquille admirable, dont Lamarck ne possédait qu'un mauvais exemplaire et qu'il a décrite par inspiration ...*". The description of DUCLOS (1840: 30) and his excellent figures (1840, Pl. 28, figs 7-12) leave no doubt about the identity of the species. This is a **valid** species, of which figures 7, 8 of DUCLOS (see FIGS. 19, 20) show a good example.

***leucophaea* Lamarck, 1811** (*Ann. Mus.* 16: 314, sp. n° 15).

DISCUSSION. LAMARCK himself (1811) says in the description: "Je présume que cette olive n'est qu'une variété de la précédente" (*O. guttata* Lamarck, 1811, remark ours). DUCLOS (1845: 19) considers it as a variety of *O. guttata* (*q.v.*). This case has already been studied in detail by TURSCH, GERMAIN & GREIFENEDER (1986), who concluded that it is a **objective junior synonym** of *O. annulata* (Gmelin, 1791), itself a nomen dubium encompassing the two distinct species *O. amethystina* (Röding, 1798) and *O. mantichora* Duclos, 1840. *O. leucophaea* Lamarck is *O. annulata* for BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***leucostoma* Lamarck, 1811** (*Ann. Mus.* 16: 317, sp. n° 26, under *funebralis*).

DISCUSSION. This word cannot be taken as an adjective. In all of Lamarck's descriptions, the first adjective following the abbreviation "O." always begins with a capital letter. Furthermore, it is quite unlikely that Lamarck would have used a Greek compound adjective in a Latin description. If not an adjective, then *leucostoma* has to be a taxon name. Appearing in the same description, *O. leucostoma* can only be interpreted as an **objective synonym** of *O. funebralis* Lamarck, 1811.

***litterata* Lamarck, 1811** (*Ann. Mus.* 16: 315, sp. n° 20).

DISCUSSION. In any case, this name (formerly used for *O. sayana* Ravenel, 1834) is a **junior homonym** of *O. litterata* (Röding, 1798), a nomen dubium (see TURSCH & *al.*, 1994).

***lugubris* Lamarck, 1811** (*Ann. Mus.* 16: 317, sp. n°.25).

ORIGINAL DESCRIPTION: 25. Olive de deuil. *Oliva lugubris. O. Cylindracea, albida; maculis fuscis diversiformibus; spirâ acuminatâ; ore violaceo.* Mus., n. 7. Mon Cabinet. Habite l'Océan des grandes Indes. Il me paroît que cette espèce n'a pas encore été figurée, et cependant elle est assez remarquable, et n'est point rare dans les collections. C'est une coquille cylindracée, à spire un peu élevée et pointue. Sur un fond blanc ou blanchâtre, elle offre quantité de taches brunes, un peu olivâtres, les unes par masses, les autres par traits en zigzags, et qui lui donnent un aspect rembruni. Son ouverture présente un fond violet, quoique la columelle soit blanchâtre. Longueur, 42 millimètres.

In LAMARCK (1822: 426, sp. n° 25) one finds: *O. testâ cylindraceâ, albidâ; maculis fuscis cæruleo-nebulatis diversiformibus; spirâ exsertiusculâ, acuminatâ; ore violaceo.*

DISCUSSION. DUCLOS (1845: 15) considers this a valid species. His illustrations (Pl. 11, figs. 5, 6) (see FIGS. 21, 22) agree with Lamarck's description and unmistakably depict the dark form of *O. caerulea* (Röding, 1798). *O. lugubris* Lamarck, 1811 is a **subjective junior synonym** (colour form) of *O. caerulea* (Röding, 1798). This is in agreement with BURCH & BURCH (1967), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986) and (as *O. episcopalis* Lamarck, *q.v.*) with BURCH & BURCH (1960) and ZEIGLER & PORRECA (1969).

***maura* Lamarck, 1811** (*Ann. Mus.* 16: 311, sp. n° 7).

DISCUSSION. The identity of this taxon is clear from the many references to illustrations. With two exceptions (Chemn. Conch. 10, t. 147, fig. 1382, depicting a dark, unrecognizable olive and Encycl., 365, fig. 3, used elsewhere by Lamarck for *funebralis*), all the cited figures represent *O. nigrita* (Karsten, 1789). The variability of the species is attested by a long French description, mainly devoted to colour pattern variations with such delightful names as "la mauresque ou la datte noire", "la veuve éthiopienne", "la datte moirée","la datte cerclée". The identity of *O. maura* is further demonstrated by the description of Duclos (1840: 27) and his excellent illustrations of many forms of this shell. Lamarck's reference to Martini's figures 472 and 473 (in MARTINI & CHEMNITZ, 1769-95) previously utilised for establishing *O. nigrita* (Karsten, 1789) (see TURSCH & *al.*, 1994) makes *O. maura* Lamarck an **objective junior synonym** of *O. nigrita* (Karsten, 1789). *O. maura* Lamarck is *O. oliva* (L., 1758), a name utilised at the time for *O. nigrita* (Karsten, 1789), for BURCH & BURCH (1960), and *O. vidua* (Röding, 1798), a name formerly used for *O. nigrita* (Karsten, 1789) for ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***mustelina* Lamarck, 1811** (*Ann. Mus.* 16: 316, sp. n° 24).

ORIGINAL DESCRIPTION: 24. Olive musteline. *Oliva mustelina. O. Cylindrica, albida; lineis fusco-rufis flexuosis longitudinalibus; spirâ brevi; ore violaceo.* Mon Cabinet. List. Conch., t. 20, f. 731. An Martini, Conch. 2, t. 48, f. 515 et 516. Habite ... probablement l'Océan américain. Cette olive paroît avoir des rapports avec la variété de l'olive glandiforme; mais son ouverture d'un beau violet, et sa forme plus cylindrique, ainsi que sa coloration, l'en distinguent. Sa longueur est de 23 à 24 millimètres.

DISCUSSION. Lamarck's description is quite vague, the figure 731 of LISTER (1682-95) is hardly recognizable, and the figures 515 and 516 of MARTINI (in MARTINI & CHEMNITZ, 1769-95) have already been cited for *O. coerulea* Link, 1807, an incorrect spelling for *O. caerulea* (Röding, 1798) (see TURSCH & *al.*, 1994). *O. mustelina* is said close to *O. glandiformis* Lamarck, 1811 (*q.v.*), which is a nomen dubium and this does not help. The violet aperture and the cylindrical body are the main indications. Fortunately DUCLOS (1845: 24), gives a good description and unequivocally depicts (Pl. 22, figs. 1, 2) (see FIGS. 23, 24) the well-known species. Interestingly, DUCLOS mentions that LAMARCK possessed only one immature specimen of this taxon, not displaying the adult characteristics. *O. mustelina* is **valid**, in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***obtusaria* Lamarck, 1822** (*Hist. Nat.* 7: 436, sp. n° 53).

ORIGINAL DESCRIPTION: 53. Olive obtusaire. *Oliva obtusaria. O. testâ majusculâ, cylindraceâ, pallidè carneâ, maculis rufocastaneis irregularibus crebris undatâ, subbifasciatâ; spirâ brevi, obtusâ, longitudinaliter fusco-lineatâ; ore albido.* Habite .... Mon Cabinet. Grande et belle olive, remarquable par sa spire courte, obtuse et rayée de brun. Columelle striée inférieurement, non calleuse. Longueur, 2 pouces 11 lignes.

DISCUSSION. From the description of Lamarck, this taxon is impossible to identify. DUCLOS (1845: 17) places it in the synonymy of *O. tremulina* Lamarck, 1811. It is better to consider it as a **nomen dubium**, in agreement with BURCH & BURCH (1967). This is *O. tremulina* Lamarck, 1811 for BURCH & BURCH (1960), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***oriola* Lamarck, 1811** (*Ann. Mus.* 16: 321, sp. n° 41).

ORIGINAL DESCRIPTION: Olive oriole. *Oliva oriola. O. Cylindracea, angusta, castanea; spirâ brevi acutâ; ore albo.* Mus.,; n. 43. Encycl., pl. 366, f. 3. Martini, Conch. 2, t. 49, f. 537 et 538. β. Variété jaune. Encycl., pl. 367, f. 2. Martini, Conch. 2, t. 49, f. 534 à 536. Habite ... probablement l'Océan indien. Les rapports de cette olive avec la précédente [*O. ispidula* ; Lamarck (not Linnaeus, 1758), 1811, remark ours] peuvent faire croire qu'elle n'en est qu'une variété: cependant, outre qu'elle est toujours un peu plus petite, elle n'est point mouchetée à l'extérieur, et son ouverture ne présente qu' une couleur blanche, rarement pâle ou altérée.

DISCUSSION. The figures 534, 535, 536, 537 and 538 of MARTINI (in MARTINI & CHEMNITZ, 1769-95) are all compatible with varieties of *oliva* (L., 1758). The figure 535 of Martini had been used for establishing *O. ispida* var α of Röding , 1798 (a nomen dubium, see TURSCH & *al.*, 1994). Figure 537 was used for *O. umbrosa* (Röding, 1798) (also a nomen dubium, see TURSCH & *al.*, 1994).

The figures in Encycl. (Pl. 366, figs. 3a, 3b) (see FIGS. 25, 26) are also compatible with the black form of *O. oliva* (L., 1758). DUCLOS (1845: 15) considers this a valid species. His illustrations on Pl. 11, figs 19, 20 are compatible with *O. oliva* (L., 1758) whereas those of Pl. 11, figs. 1, 2 probably depict another species (with a reticulated pattern and flaring aperture). The name *O. oriola* Lamarck, 1811 is usually thought to be a dark form of *O. oliva* (L., 1758), but this is not consistent with the existence of a yellow variety β, described by Lamarck. It is better to consider *O. oriola* Lamarck, 1811 as a **subjective junior synonym** of *O. oliva* (L., 1758). *O. oriola* Lamarck, 1811 is *O. ispidula* for BURCH & BURCH (1960), a form of *O. oliva* (L., 1758) for BURCH & BURCH (1967), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***peruviana* Lamarck, 1811** (*Ann. Mus.* 16: 317, sp. n° 28).

ORIGINAL DESCRIPTION: 28. Olive du Pérou. *Oliva peruviana. O. Ovata, subventricosa, albida; punctis fusco-rubris, acervatim undatis; spirâ brevi mucronata; ore albo.* Mus., n. 32. Encycl., pl. 367, f. 4. β. La même plus colorée, plus rembrunie. *O. Dombeyana.* Mus., n. 34. Habite les côtes du Pérou, d'où elle fut rapportée par *Dombey*. Cette olive constitue une espèce distincte, par sa forme particulière et ses couleurs. Elle est ovale, bombée, et offre, sur un fond blanchâtre, quantité de petites taches punctiformes, rouges ou d'un rouge-brun, formant tantôt de petits amoncellemens, tantôt des linéoles en zigzag. La spire est fort petite, courte, mucronée. Longueur 42 à 45 millimètres.

In LAMARCK (1822: 427, sp. 28) one finds in addition: [b] *Eadem intensiùs colorata.*

DISCUSSION. In the original description, the only thing in favour of the current interpretation is the locality, Peru. The figures in Encycl. (Pl. 367, figs. 4a, 4b) (see FIGS. 27, 28) are not convincing at all. What are the bulge on the last spire whorl, the numerous, fine columellar plications very carefully drawn on fig. 4a (see FIG. 27), the double row of little points on the suprafasciolar zone ? These features are rarely (if ever seen) in the shell we today call *O. peruviana* Lamarck, 1811. The described colour pattern is also not very characteristic. DUCLOS (1845: 26) insists on the great variablity of this taxon and depicts (Pl. 16, figs. 9-16) varieties that unmistakably correspond to the current use of *O. peruviana*. A good example is given in his Pl. 16, figs. 9-10 (see FIGS. 29, 30). This allows us to save this familiar taxon as **valid**, in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***pica* Lamarck, 1811** (*Ann. Mus.* 16: 310, sp. n° 4).

ORIGINAL DESCRIPTION: 4. Olive pie. *Oliva pica. O. Fusca, albo maculata : maculis pluribus subtrigonis; ore candido.* Mus., n. 5. Mon Cabinet. Habite les mers de la Nouvelle-Hollande. Sur une couleur brune ou d'un fauve très-rembruni, cette olive présente des taches d'un beau blanc, irrégulières, et dont plusieurs sont trigones ou deltoïdes. La couleur blanche néanmoins est celle du fond de la coquille, quoique le brun soit dominant sur sa robe. Cette olive est grande, longue de 8 centimètres, cylindracée, un peu atténuée vers la spire. Son ouverture est d'une grande blancheur.

DISCUSSION. There is no further information in LAMARCK (1822: 419, sp. n° 4). The described characters could apply equally well to several species, such as *O. concinna* Marrat, 1870 and *O. tremulina* Lamarck, 1811. There is no reference illustration. DUCLOS (1845: 18) considers this as a synonym of *O. textilina* Lamarck, an older name for *O. sericea* (Röding, 1798). This should be considered as a **nomen dubium**. This taxon is valid for PETUCH & SARGENT (1986), is *O. tremulina* for BURCH & BURCH (1960), maybe a form of *O. tremulina* Lamarck, 1811. for ZEIGLER & PORRECA (1969) and ? *O. concinna* Marrat, 1870 for WAGNER & ABBOTT (1978).

***reticularis* Lamarck, 1811** (*Ann. Mus.* 16: 314, sp. n° 16).

ORIGINAL DESCRIPTION: 16. Olive réticulaire. *Oliva reticularis. O. Cylindracea, alba, subbifasciata; lineis fulvis, subpunctatis flexuoso-angulatis; spirâ acutâ.* Mus., n. 12. Encycl., pl. 361, f. 1. Martini, Conch. 2, t. 51, f. 561. Habite ... Sur un fond blanc, cette olive offre quantité de lignes en zigzags, rousses, subponctuées. Dans les espaces qu'embrassent deux bandes transverses, ces lignes, plus épaissies et plus colorées, imitent en quelque sorte des caractères d'écriture. Cette olive est un peu bombée, a une spire pointue, et ne présente qu'une couleur blanche à son ouverture. Sa longueur est d'environ 45 millimètres. Le bord supérieur du dernier tour est comme dentelé par des taches d'un brun violet, composées de lignes repliées en faisceau.

DISCUSSION. Martini's fig. 561 (in MARTINI & CHEMNITZ, 1769-95) is unrecognizable. The

figures in Encycl. (Pl. 361, figs. 1a, 1b) (see FIGS. 31, 32) are very clear and depict the taxon universally known under *O. reticularis*. One should, however, note that the very concave lip is not at all a common feature. The last line of the French description is of good diagnostical value. DUCLOS (1845: 16) gives a long list of localities (mostly erroneous), but insists on the great variability of this taxon, evidenced by his illustrations (Pl. 10, figs. 1-12). This name is **valid**, in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

There remains a problem of species delimitation because it is possible that *O. reticularis* Lamarck intergrades with *O. fulgurator* (Röding, 1798). This complex biological problem cannot be solved in the context of this paper and requires separate treatment.

***sanguinolenta* Lamarck, 1811** (*Ann. Mus.* 16: 316, sp. n° 23).

DISCUSSION. The identity of this species is clear from the original description, the cited figures and mainly from the description of DUCLOS (1845: 24) and his illustrations (Pl. 22, figs. 14-16) accurately depicting the species. Lamarck's citation of Martini's figure 512, previously utilised for establishing *O. reticulata* (Röding, 1798) (see TURSCH & *al.*, 1994) makes *O. sanguinolenta* Lamarck an **objective junior synonym** of *O. reticulata* (Röding, 1798).This is in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***scripta* Lamarck, 1811** (*Ann. Mus.* 16: 315, sp. n° 21).

ORIGINAL DESCRIPTION: 21. Olive écrite. *Oliva scripta. O. Cylindracea, reticulo tenui fulvo colorata; fasciis characterum fuscorum obsoletis; spirâ brevi; ore coerulescente.* Mus., n. 27. Encycl., pl. 362, f. 4. β. La même ? à spire plus élevée. Habite... Cette olive n'est point rare dans les collections, et cependant je n'en connois de figure que dans l'Encyclopédie. Elle est plus ou moins foncée en couleur selon que le réseau fin et d'un fauve brun qui la couvre est plus ou moins apparent. Ses deux zônes transverses, composées de traits bruns, presqu'en forme de lettres, sont aussi plus ou moins exprimées selon les individus. Les plus grands n'ont que 47 millimètres. In LAMARCK (1822: 425, sp. n° 21), the form β is replaced by : [b] *Var. spirâ elatiore*. Mon cabinet.

DISCUSSION. The figures in Encycl. (Pl. 362, figs. 4a, 4b) (see FIGS. 33, 34) are quite clear but not completely unambiguous. The description of DUCLOS (1845: 16) and his fine illustrations (Pl. 11, figs. 13-14) leave no doubt as to the identity of this Western Atlantic taxon. This name is **valid**. This is in agreement with PETUCH & SARGENT (1986). The name *O. scripta* Lamarck, 1811 was applied by ZEIGLER & PORRECA (1969) and WAGNER & ABBOTT (1978) to another species with an Indo-Pacific distribution. This interpretation is not compatible with the data from DUCLOS (1845).

***senegalensis* Lamarck, 1811** (*Ann. Mus.* 16: 318, sp. n° 29).

ORIGINAL DESCRIPTION: 29. Olive du Sénégal. *Oliva Senegalensis. O. Ovata, ventricosa, albida; lineis rubris longitudinalibus, undatim flexuosis; spirâ breviusculâ.* Mus., n. 33. Encycl. , pl. 364, f. 3. Favanne, Conch., pl. 19, fig. R. D'Argenv., Conch., t. 12, fig. S. Habite les côtes du Sénégal. Cette olive, qu'on nomme vulg. la *papeline*, est fort remarquable par ses lignes pourpres ou d'un rouge-brun, disposées longitudinalement et un peu en zigzag, sur le fond blanchâtre de la coquille. Elle est ovale, bombée, et terminée supérieurement par une spire en cône court et pointu. Sa longueur est de 38 millimètres.

In LAMARCK (1822: 428, sp. n° 29), the reference to d' ARGENVILLE (1742) becomes: pl. 13., fig. S.

DISCUSSION. The figures of FAVANNE (1780), d' ARGENVILLE and that in Encycl. (Pl. 364, fig. 3) (see FIG. 35) unmistakably depict *O. peruviana* Lamarck, 1811. Indeed, DUCLOS (1845: 26) considers *O. senegalensis* Lamarck is his variety "b" of that species. *O. senegalensis* Lamarck, 1811 is a **subjective junior synonym** of *O. peruviana* Lamarck, 1811. This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***"sepulchuralis* Lamarck, 1810"** (auct.)

This is a **misspelling** for *sepulturalis* in BURCH & BURCH (1967: 510), that has been often used by subsequent authors. It is a form of *O. vidua* (Röding, 1798) [this is *O. nigrita* (Karsten, 1789) for BURCH & BURCH (1967)], WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***sepulturalis* Lamarck, 1811** (*Ann. Mus.* 16: 311, sp.n° 8).

ORIGINAL DESCRIPTION: 8. Olive sépulturale. *Oliva sepulturalis. O. Cylindracea, apice retusa, viridescens; fasciis duabus nigris interruptis; ore candido.* Mus., n. 7. Encycl., pl. 365, f. 1. Gualt. ind., t. 24, fig. E. β. Var. à taches longitudinales. Habite... probablement l'Océan des grandes Indes. Elle a évidemment des rapports avec la précédente (*O. maura*, remark ours), et cependant elle en est constamment distincte. Sur un fond verdâtre, ou d'un cendré verdâtre, cette olive présente deux rangées transverses de taches noires et irrégulières, disposées sur deux zônes pâles peu apparentes. Dans la variété β, outre les deux rangées transverses de taches noires, on voit plusieurs bandes noires, longitudinales et un peu irrégulières qui occupent presque toute la longeur de la coquille. Sa taille est à peu près la même que celle de l'olive maure. Quoique très-blanche à son ouverture, la base de sa columelle offre une légère teinte couleur de chair.

In LAMARCK (1822: 421, sp. n° 8) β, becomes: [b] *Var. testâ longitudinaliter nigro-maculatâ.* Mon cabinet. Habite.... l'Océan des grandes Indes ? Mon cabinet. Sa spire est extrêmement courte, rétuse. Longueur, 2 pouces 3 lignes.

DISCUSSION. The cited figure E β of GUALTIERI (1742) is not recognizable. The figure in Encycl. (Pl. 365, fig. 1) (see FIG. 36) clearly depicts *O. nigrita* (Karsten, 1789), (see TURSCH & *al.*, 1994). This is hardly a distinct colour form. DUCLOS (1845: 27) considers *O. sepulturalis* Lamarck, 1811 as the variety 2 "ponctuée avec deux fascies" of *O. maura* Lamarck, a name formerly used for *O. nigrita* (Karsten, 1789). All evidence indicates that *O. sepulturalis* is a **subjective junior synonym** of *O. nigrita* (Karsten, 1789). This is in agreement with ZEIGLER & PORRECA (1969), considering *O. sepulturalis* Lamarck as a form of *O. vidua* (Röding, 1798), a name formerly used for *O. nigrita* (Karsten, 1789), and BURCH & BURCH (1960) considering it as a variety of *O. oliva* (L., 1758), another name formerly used for *O. nigrita* (Karsten, 1789).

***tessellata* Lamarck, 1811** (*Ann. Mus.* 16: 320, sp. n° .38).

DISCUSSION. The identity of this species is clear from the original description, the cited figures, the good illustrations in Encycl. (Pl. 368, figs. 1a, 1b) and the comments of DUCLOS (I845: 29). Unfortunately, Lamarck's citation of Martini's figure 493 and 494 (in MARTINI & CHEMNITZ, 1769-95) previously utilised for establishing *O. olivacea* (Karsten, 1789) (see TURSCH & *al.*, 1994) makes the familiar *O. tessellata* Lamarck an **objective junior synonym** of *O. olivacea* (Karsten, 1789). *O. tessellata* Lamarck is a valid species for ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***textilina* Lamarck, 1811** (*Ann. Mus.* 16: 309, sp. n°2).

DISCUSSION. The identity of this species is clear from the original description, the cited figures and the good illustrations in Encycl. (Pl. 362, figs. 5a, 5b). Lamarck's citation of Martini's figures 559 and 561 (in MARTINI & CHEMNITZ, 1769-95) (the latter cited only in LAMARCK 1822: 418, sp. n° 2), previously utilised for establishing *O. sericea* (Röding, 1798) (see TURSCH & *al.*, 1994) makes *O. textilina* Lamarck an **objective junior synonym** of *O. sericea* (Röding, 1798). This is in agreement with WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986). The species is valid for ZEIGLER & PORRECA (1969).

***tigrina* Lamarck, 1811** (*Ann. Mus.* 16: 322, sp. n° 44).

ORIGINAL DESCRIPTION: 44. Olive tigrine. *Oliva tigrina. O. Cylindraceo-ventricosa, albida; punctis lividis lineisque fuscis flexuoso-angulatis; spirâ brevi.* Mus., n. 17. Gualt. ind., t. 23, fig. pp? Martini, Conch. 2, t. 45, f. 475. Habite... Les rapports de cette olive la rapprochent de l'espèce n. 12 (*O. episcopalis* Lamarck, 1811, remark ours) et de celle n. 13 (*O. venulata* Lamarck, 1811, remark ours); mais elle en est très-distincte. Elle est cylindracée, ventrue ou bombée, à spire très-courte, mucronée, et à bords des sutures non flambés. Elle offre, sur un fond blanchâtre, des points cendrés, livides, rangés en lignes fléchies, et en outre des lignes brunes en zigzags, formant des ondes longitudinales. Ouverture blanche. Longueur, 5 centimètres.

DISCUSSION. The cited illustration of Martini (in MARTINI & CHEMNITZ, 1769-95) is compatible with the present, unanimous concept of *O. tigrina*. The description of DUCLOS (1845: 25) and his excellent illustrations (Pl. 23, figs. 7-12, 17-19 and Pl. 36, figs. 13, 14) leave no doubt. His figures Pl. 23, figs. 7-8 (see FIGS. 37, 38) are a good example. This taxon is **valid** in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***tremulina* Lamarck, 1811** (*Ann. Mus.* 16: 310, sp. n° 5).

ORIGINAL DESCRIPTION: 5. Olive tremuline. *Oliva tremulina. O. Albida; lineis longitudinalibus, fusco violaceis, flexuosis, remotiusculis; fasciis binis, fuscis; ore pallido.* Mus., n. 3. Mon Cabinet. List. Conch., t. 727, f. 14. Habite... Grande et belle olive, qui paroît avoir des rapports avec l'espèce n. 3 (*O. erythrostoma*, remark ours), mais qui, même dans tous les âges, s'en distingue par ses lignes longitudinales plus séparées, jamais nuées de jaune, et par la couleur pâle de son ouverture. Elle a 77 millimètres de longueur. La bande oblique de sa base est tachetée de brun.

In LAMARCK (1822: 420, n° 5), the French description is very similar but the Latin description becomes: "*O. testâ albido-lutescente; lineis violaceo-fuscis longitudinalibus flexuosis remotiusculis; fasciis duabus fuscis; ore pallido*".

DISCUSSION. The cited illustration of LISTER (1682-1695) is compatible with the present concept. The description of DUCLOS (1845: 17) and his illustrations (Pl. 12, figs. 1-9) leave no doubt on the identity of the taxon. His illustrations Pl. 12, figs. 3-4 (see FIGS. 39, 40) give a good example. This name is **valid** but the affinities of this taxon with the closely related *O. miniacea* (Röding, 1798) remain a problem. *O. tremulina* Lamarck is probably valid for BURCH & BURCH (1967), valid for ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986). It was considered to be a form of *O. miniacea* (Röding, 1798) by JOHNSON (1928: pp. 8-9), whose arguments have not yet been objectively refuted. This complex biological problem cannot be solved in the context of this paper and requires separate treatment.

***tricolor* Lamarck, 1811** (*Ann. Mus.* 16: 316, sp. n° 22).

ORIGINAL DESCRIPTION: 22. Olive tricolore. *Oliva tricolor. O. Cylindracea, viridis, luteo alboque tessellatim maculata; spirâ brevi variegatâ.* Mus., n. 22. Encycl., pl. 365, f. 4. An List. Conch., t. 739, f. 26 ? Gualt. ind., t. 4, fig. I, L, N. Martini, Conch. 2, t. 48, f. 511. Habite l'Océan des grandes Indes, les côtes de Timor, de Java, etc. Olive de moyenne taille, très-commune dans les collections, et néanmoins fort jolie par les couleurs dont elle est ornée. Sur un fond blanc, presqu'entièrement caché par les autres couleurs, elle offre deux ou trois zônes transverses, verdâtres, et dans leurs intervalles, quantité de petites taches nuées de vert, de jaune et de blanc. Son ouverture est blanche ou d'un blanc bleuâtre; mais la base de sa columelle est teinte de couleur de chair. Longueur, 44 à 45 millimètres.

DISCUSSION. The cited figures of GUALTIERI (1742) represent different shells, amongst which *O. tricolor* can hardly be recognized. The cited figures of LISTER (1682-95) and MARTINI (in MARTINI & CHEMNITZ, 1769-95) are compatible with the present, unanimous concept of the species. The figures in Encycl. (Pl. 365, figs. 4a, 4b) (see FIGS. 41, 42) are quite clear. The description of DUCLOS (1845: 25) and his excellent figures (Pl. 22, figs. 9-11) leave no doubt. This species is **valid**, in agreement with ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***undata* Lamarck, 1811** (*Ann. Mus.* 16: 318, sp. n° 31).

DISCUSSION. The figures in Encycl. (Pl.364, figs. 7a, 7b) unmistakably depict *O. bulbosa* (Röding, 1798). The cited illustrations of LISTER (1682-95; Pl. 740, fig. 29) and CHEMNITZ (1786; Pl. 147, fig. 1373) are also compatible with this interpretation. DUCLOS (1845: 27) considers this as the variety 3 ("avec des lignes flexueuses ou en zigzag") of *O. inflata* Lamarck (an older name for *O. bulbosa*). Lamarck's citation of Martini's figures 507 and 508, previously utilised for establishing *O. bulbosa* (Röding, 1798) (see TURSCH & *al.*, 1994) makes *O. undata* Lamarck, 1811 an **objective junior synonym** of *O. bulbosa* (Röding, 1798). This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***undatella* Lamarck, 1811** (*Ann. Mus.* 16: 326, sp. n°. 55).

ORIGINAL DESCRIPTION: 55. Olive ondatelle. *Oliva undatella. O. Ovato-conica, albo fusquoque varia, extremitatibus fasciata; lineis undatis fuscis dorsalibus.* Mon Cabinet. Habite l'Océan pacifique, sur les côtes d'Acapulco, d'où M. Bonplan l'a rapportée. Petite olive ovale-conique, qui se rapproche de la précédente (remark ours: *O. conoidalis* Lamarck, 1811, not an *Oliva*) par ses rapports, mais dont la spire est moins élevée, la columelle différemment striée, et les caractères de coloration un peu particuliers. Longueur 12 à 13 millimètres.

In LAMARCK (1822: 438, sp. n° 58) the description becomes: "*O. testâ ovato-conicâ, fuscente; anfractuum margine superiore fasciâ luteâ angustâ, transversim fusco-lineatâ; zonâ baseos latâ luteâ, lineis fuscis pictâ; ore fusco*".

Also: "Habite l'Océan Pacifique, sur les côtes d'Acapulco. MM. de Humboldt et Bonpland."

DISCUSSION. Excepted for the locality, this familiar taxon would be difficult to recognise from the original description. It is fortunate that the description of DUCLOS (1844: 12) and his fine illustrations (Pl. 6, figs. 5-10) leave no doubt about the identity of this species. His illustrations Pl. 6, figs. 5, 6 (see FIGS. 43, 44) are good examples. This species is **valid**. This is in agreement with BURCH & BURCH (1960), ZEIGLER & PORRECA (1969), WAGNER & ABBOTT (1978) and PETUCH & SARGENT (1986).

***ustulata* Lamarck, 1811** (*Ann. Mus. 16*: 320, sp. n° 36).

ORIGINAL DESCRIPTION: 36. Olive rotie. *Oliva ustulata. O. Cylindracea, fusco-fulva, lineis albidis transversis cingulata; spirâ acutâ.* Mus., n. 30. Mon Cabinet. An Chemn. Conch. 10, t. 147, f. 1378 ? Habite ... Cette olive est une espèce facilement distincte par ses cordelettes blanchâtres et transversales. Elle est cylindracée, à spire un peu élevée et pointue. Sa couleur principale varie du jaune fauve, au roux brun ou marron, et quelquefois à la couleur brune presque noire. Longueur 39 millimètres et au-delà.

DISCUSSION. The figure of CHEMNITZ (1786) (cited with a question mark) is possibly *O. reticularis* Lamarck, 1811 form *bifasciata* Küster, 1878. The identity of this shell is not clear and the name should be a **nomen dubium**. *O. ustulata* Lamarck is a synonym of *O. reticularis* Lamarck for DUCLOS (1845: 16). It is *O. spicata* (Röding, 1798) for BURCH & BURCH (1960), a form of *O. spicata* (Röding, 1798) for ZEIGLER & PORRECA (1969), possibly *O. fuscata* Marrat, 1870 for WAGNER & ABBOTT (1978), a colour form of *O. venulata* Lamarck for PETUCH & SARGENT (1986).

***venulata* Lamarck, 1811** (*Ann. Mus.* 16: 313, sp. n°13).

DISCUSSION. The figure in Encycl. (pl. 361, fig. 5) could depict any of several American taxa. In any case, Lamarck's reference to Martini's fig. 488 (in MARTINI & CHEMNITZ, 1769-95), already used for establishing *O. litterata* (Röding, 1798) makes it an **objective junior synonym** of *O. litterata* (Röding, 1798) which is itself a nomen dubium (TURSCH & *al.*, 1994). This is a valid species for DUCLOS (1845: 25; Pl. 17, figs. 5, 6; Pl. 22, figs. 19, 20; Pl. 33, fig.11, illustrating rather dissimilar shells) and for PETUCH & SARGENT (1986). It is a form of *O. spicata* (Röding, 1798) for BURCH & BURCH (1960), ZEIGLER & PORRECA (1969) and WAGNER & ABBOTT (1978).

"*vermiculata* Lamarck" (auct.).

Misquotation. This is cited by GRAY (1758: 44) as a synonym of his sp. 12, *Strephona reticularis* (Lamarck, 1811). *O. vermiculata* Lamarck does not exist.

***zeilanica* Lamarck, 1822** (*Hist. Nat.* 7: 436, sp. n° 54).

ORIGINAL DESCRIPTION: 54. Olive de Ceylan. *Oliva Zeilanica. O. testâ cylindraceâ, aurantio-luteâ; lineis longitudinalibus creberrimis undatim flexuosis fusco-coerulescentibus; spirâ exserto-acutâ, fusco-sublineatâ.* Habite les mers de Ceylan. M. Macleay. Mon cabinet. Espèce fort jolie par sa coloration, offrant, sur un fond d'un jaune presque orangé, quantité de lignes longitudinales serrées, ondées, légèrement fléchies, un peu en réseau, et d'un brun nué de bleu. Ouverture blanche. Longueur, 2 pouces 7 lignes.

DISCUSSION. This description could apply to many large, yellow olives and the name should be a **nomen dubium**. DUCLOS (1845: 17) considered this is a synonym of *tremulina* Lamarck, 1811, an opinion repeated by BURCH & BURCH (1960), ZEIGLER & PORRECA (1969) and WAGNER & ABBOTT (1978). For PETUCH & SARGENT (1986) it is a colour form of *O. tremulina* Lamarck, 1811.

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Figures 1-22.

1, 2:	*O. bicingulata* Lamarck, 1811.	Encycl., Pl. 364, figs. 1a, 1b.
3, 4:	*O. candida* Lamarck, 1811.	Encycl., Pl. 368, figs. 4a, 4b.
5, 6:	*O. elegans* Lamarck, 1811.	Encycl., Pl. 367, figs. 3a, 3b.
7, 8:	*O. elegans* Lamarck, 1811.	Encycl., Pl. 362, figs. 3a, 3b.
9, 10:	*O. fabagina* Lamarck, 1811.	Encycl., Pl. 363, figs. 5a, 5b.
11:	*O. flammulata* Lamarck, 1811.	Encycl., Pl. 367, fig. 5.
12, 13:	*O. fulminans* Lamarck, 1811.	Encycl., Pl. 364, figs. 4a, 4b.
14:	*O. funebralis* Lamarck, 1811.	Encycl., Pl. 365, fig. 3.
15, 16:	*O. fusiformis* Lamarck, 1811.	Encycl., Pl. 367, figs. 1a, 1b.
17, 18:	*O. inflata* Lamarck, 1811.	Encycl., Pl. 364, figs. 5a, 5b.
19, 20:	*O. irisans* Lamarck, 1811.	Duclos in Chenu, Pl. 30, figs. 7, 8.
21, 22:	*O. lugubris* Lamarck, 1811.	Duclos in Chenu, Pl. 11, figs. 5, 6.

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Figures 23-44.

23, 24:	*O. mustelina* Lamarck, 1811.	Duclos in Chenu, Pl. 22, figs. 1, 2.
25, 26:	*O. oriola* Lamarck, 1811.	Encycl., Pl. 366, figs. 3a, 3b.
27, 28:	*O. peruviana* Lamarck, 1811.	Encycl., Pl. 367, figs. 4a, 4b.
29, 30:	*O. peruviana* Lamarck, 1811.	Duclos in Chenu, Pl. 16, figs. 9, 10.
31, 32:	*O. reticularis* Lamarck, 1811.	Encycl., Pl. 361, figs. 1a, 1b.
33, 34:	*O. scripta* Lamarck, 1811.	Encycl., Pl. 362, figs. 4a, 4b.
35:	*O. senegalensis* Lamarck, 1811.	Encycl., Pl. 364, fig. 3.
36:	*O. sepulturalis* Lamarck, 1811.	Encycl., Pl. 365, fig. 1.
37, 38:	*O. tigrina* Lamarck, 1811.	Duclos in Chenu, Pl. 21, figs. 7, 8.
39, 40:	*O. tremulina* Lamarck, 1811.	Duclos in Chenu, Pl. 11, figs. 3, 4.
41, 42:	*O. tricolor* Lamarck, 1811.	Encycl., Pl. 365, figs. 4a, 4b.
43, 44:	*O. undatella* Lamarck, 1811.	Duclos in Chenu, Pl. 5, figs. 5, 6.

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Index of *Oliva* names (valid names in ***bold***).

"*O. alba* Lamarck" (auct.). Misquotation.
O. angulata Lamarck, 1811. objective junior synonym of *O. incrassata* (Lightfoot, 1786).
O. araneosa Lamarck, 1811. objective junior synonym of *O. spicata* (Röding, 1798).
O. avellana Lamarck, 1811. nomen dubium.
O. bicincta Lamarck, 1822. objective junior synonym of *O. bicingulata* Lamarck, 1811.
O. bicingulata Lamarck, 1811. subjective junior synonym (colour form) of *O. bulbosa* (Röding, 1798).
O. candida Lamarck, 1811. nomen dubium.
"*O. cruentata* Lamarck" (auct.). Misquotation.
O. decorticata Lamarck, 1811. nomen dubium.
O. dombeyana Lamarck, 1811. colour form of *O. peruviana* Lamarck, 1811.
O. elegans Lamarck, 1811: valid.
O. episcopalis Lamarck, 1811: subjective junior synonym of *O. caerulea* (Röding, 1798).
O. erythrostoma Lamarck, 1811: objective junior synonym of *O. miniacea* (Röding, 1798).
O. fabagina Lamarck, 1811: subjective junior synonym (maybe a form) of *O. bulbosa* (Röding, 1798).
O. flammulata Lamarck, 1811: valid.
O. fulminans Lamarck, 1811: colour form of *O. nigrita* (Karsten, 1789).
O. funebralis Lamarck, 1811: nomen dubium.
O. fusiformis Lamarck, 1811: subjective junior synonym of *O. fulgurator* (Röding, 1798).
"*O. gibbosa* Lamarck": misquotation (and not an *Oliva*).
O. glandiformis Lamarck, 1811: nomen dubium.
O. granitella Lamarck, 1811: subjective junior synonym of *O. sericea* (Röding, 1798).
O. guttata Lamarck, 1811: junior homonym of *O. guttata* Fischer, 1807.
O. harpularia Lamarck, 1811: nomen dubium.
O. hepatica Lamarck, 1811: nomen dubium.
O. inflata Lamarck, 1811: subjective junior synonym of *O. bulbosa* (Röding, 1798).
O. irisans Lamarck, 1811: valid.
"*O. ispidus* Lamarck" (auct.): misquotation.
O. leucophaea Lamarck, 1811: objective junior synonym of *O. annulata* (Gmelin, 1791), itself a nomen dubium.
O. leucostoma Lamarck, 1811: objective synonym of *O. funebralis* Lamarck, 1811.
"*O. leukophaea* Lamarck" auct.: misspelling for *O. leucophaea*.
O. litterata Lamarck, 1811: junior homonym of *O. litterata* (Röding, 1798), a nomen dubium.
O. lugubris Lamarck, 1811: subjective junior synonym (colour form) of *O. caerulea* (Röding, 1798).
O. maura Lamarck, 1811: objective junior synonym of *O. nigrita* (Karsten, 1789).
O. mustelina Lamarck, 1811: valid.
"*O. mustellina* Lamarck" auct.: misspelling for *O. mustelina*.
O. obtusaria Lamarck, 1811: nomen dubium.
O. oriola Lamarck, 1811: subjective junior synonym of *O. oliva* (L., 1758).
O. peruviana Lamarck, 1811: valid.
O. pica Lamarck, 1811: nomen dubium.
O. reticularis Lamarck, 1811: valid.
O. sanguinolenta Lamarck, 1811: objective junior synonym of *O. reticulata* (Röding, 1798).
O. scripta Lamarck, 1811: valid.
O. senegalensis Lamarck, 1811: subjective junior synonym of *O. peruviana* Lamarck, 1811.
"*O. sepulchuralis* Lamarck" (auct.): misspelling for *O. sepulturalis* Lamarck, 1811.
O. sepulturalis Lamarck, 1811: subjective junior synonym of *O. nigrita* (Karsten, 1789).
O. tessellata Lamarck, 1811: objective junior synonym of *O. olivacea* (Karsten, 1789).
O. textilina Lamarck, 1811: objective junior synonym of *O. sericea* (Röding, 1798).
O. tigrina Lamarck, 1811: valid.
O. tremulina Lamarck, 1811: valid.
O. tricolor Lamarck, 1811: valid.
O. undata Lamarck, 1811: objective junior synonym of *O. bulbosa* (Röding, 1798).
O. undatella Lamarck, 1811: valid.
O. ustulata Lamarck, 1811: nomen dubium.
O. venulata Lamarck, 1811: objective junior synonym of *O. litterata* (Röding, 1798), itself a nomen dubium.
"*O. vermiculata* Lamarck" (auct.). Misquotation.
O. zeilanica Lamarck, 1811: nomen dubium.

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The microstructure of the shell in the genus *Oliva*
(Studies on Olividae. 24)

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KEYWORDS: Mollusca, Gastropoda, Olividae, *Oliva*, shell structure, taxonomy.

SUMMARY. The microstructure of the shell of 75 taxa in the genus *Oliva* has been examined and compared to that of some Olividae species belonging to other groups. Useful taxonomic characters are obtained even by non-destructive examination of the surface. Implications for systematics are discussed.

RESUME. La microstructure de la coquille de 75 taxa du genre *Oliva* a été examinée et comparée à celle de quelques espèces d'Olividae d'autres groupes. Des caractères taxonomiques utiles sont obtenus, même par examen non-destructif de la surface. Les implications pour la systématique sont discutées.

1. INTRODUCTION

1.1. Purpose.

Shell mineralogy and microstructure have been sometimes utilised at the higher taxonomic levels (above Family rank) in Gastropods (see for instance LINDBERG, 1986 and MCLEAN, 1990), where they have a deep phylogenetic meaning (see HAAS 1981; HEDEGAARD, 1995). Comparative studies at the species level are much rarer, but shell structural characters have been used, for example in the Muricidae (PETITJEAN, 1972) and the Littorinidae (TAYLOR & REID, 1990).

The aim of the present study is to investigate the potential of the structure of the shell to find additionals characters for the classification of the genus *Oliva*, where the scarcity of objective taxonomic characters has posed serious problems (see TURSCH & GERMAIN, 1985). Most characters available today are morphometric. Additional, quantitative information might be most useful, especially if it is of a different nature.

1.2. The shell of neogastropods.

Very numerous works deal with the shell structure of molluscs. After the classical work of BØGGILD (1930), general reviews and extensive lists of references will be found for instance in PETITJEAN (1972), TERMIER & TERMIER (1972), VOVELLE (1972) and MAJEWSKE (1974). Only the most basic notions, indispensable for understanding, will be recalled here.

In neogastropods, the shell (without the periostracum) consists mainly of calcium carbonate in the aragonite crystal form. Three distinct layers, stacked parallel to the surface are usually present. Each of these layers has a typical ***crossed-lamellar structure*** (abbr.: ***XLM***). This is a lamellate "plywood-like" fabric (TAYLOR & REID, 1990) as depicted in Fig. 1. It shows three large ***third order lamellae***, each formed by a series of oblique, parallel ***second order lamellae***, consisting themselves in bundles of small ***first order lamellae***.

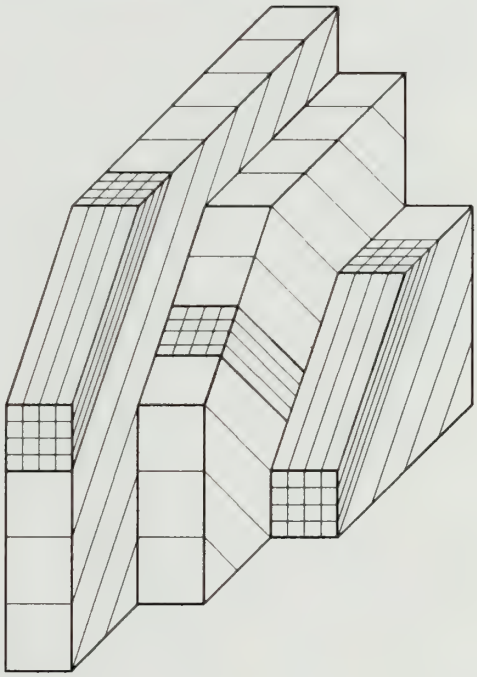

Figure 1. Crossed lamellar crystal structure of a neogastropod shell, schematised (see text, section 1.2.).

The usual three layers of the neogastropod shell are orientated in different directions. Usually the external and the inner layers are orientated in a transversal direction (third order lamellae perpendicular to the growth lines) and the middle layer is longitudinal (third order lamellae parallel to the growth lines). The three layers are not independent but are fused together at their limits by a gradational transition, as shown by local misorientation and torsion in the pattern. The complex structure of the neogastropod shell (strongly evocative of the composite materials of our modern technology) probably yields greatly increased mechanical resistance.

Within a given layer, the orientation of the stack of juxtaposed, parallel lamellae can be described by their **direction** (*i.e.* the angle formed on the surface of the layer by the trace of the lamella with a given reference line) and their **tilt** (*i.e.* the dihedral angle of the plane of a lamella with the plane of the surface of the layer). These notions are schematised in Fig. 2.

As will be seen below, shells present some variability in the tilt of the XLM. Even a small tilt, as shown on Fig. 3, can considerably modify the aspect of a radial (perpendicular to the surface) section. The expected crossed-lamellar structure will appear only if the lamellae are perpendicular to the surface with an direction parallel to the cut (Fig. 3A). The pattern will appear as parallel lines (Fig. 3A) if the lamellae are tilted even slightly from 90°.

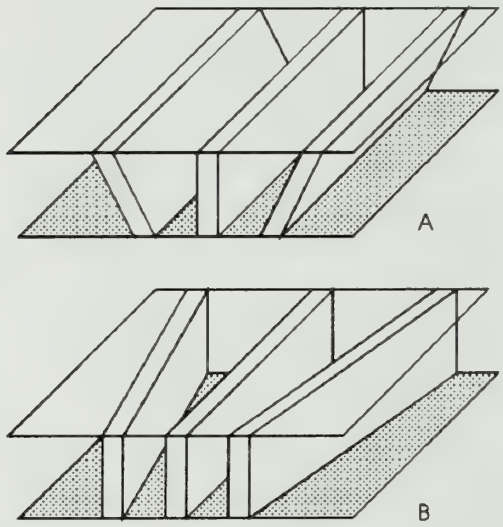

Figure 2. Direction and tilt of lamellae. **2A**: three lamellae with same direction and different tilts. **2B**: three lamellae with different directions and same tilt.

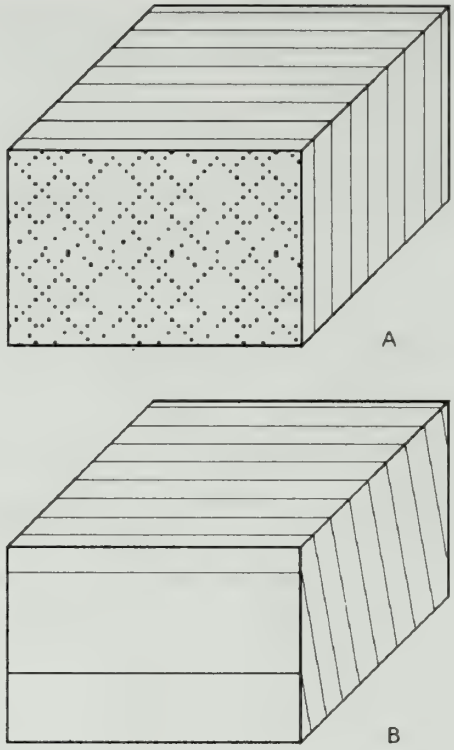

Figure 3. Effect of the tilt of lamellae on the aspect of radial sections. **3A**: lamellae perpendicular to surface. **3B**: lamellae with slight tilt.

1.3. The shell of Olividae.

Only a few, very succinct descriptions of the shells of Olividae are found in the litterature. BØGGILD (1930: 315) says: "The shells of different forms of *Oliva*, *Olivella* and *Ancilla* examined by me all show the ordinary structure with three layers. There may, in some instances, be faint traces of an upper, longitudinal layer but it is not formed as a distinct, separate layer. BOWERBANK (1844) places the *Oliva* among the gastropods which have three layers of which the middle one has transverse lamellae; there may, perhaps be other species than those examined by me, which possess the said middle layer". MAJEWSKE (1974, Table 7, p. 79) reports only that the shell of Olividae is composed of aragonite and consists in 3 to 5 cross-lamellar layers. WILMOT *et al.* (1992) have studied the microstructural parameters of the XLM elements of *Oliva sayana*.

At the macroscopic scale, the Olividae share with some other gastropod families (Conidae, Cypraeidae, Ovulidae, Marginellidae) an interesting particularity: the dissolution of the inner, earlier volutions of the shell, to make

place for growth of the animal (KOHN *et al.*, 1979; ZEIGLER & PORRECA, 1969).

Much more complex structures are met in the thickened parts of the *Oliva* shell: the spire, the columella and the fasciolar region. This study is limited to the simpler, central part of the body whorl. We shall concern ourselves only with the largest of these crystalline units and the word "*lamellae*" will refer here to the third order lamellae, unless otherwise stated.

2. MATERIAL

The taxonomy and the nomenclature of the genus *Oliva* are not yet fully stabilised. The status of many of the taxa here below still needs revision and some of the names utilised here will certainly have to be changed later. No collection numbers are given for the shells that have been cut (the specimens are destroyed). They are given for all the shells examined by non-destructive methods. Abbreviations: AM: Zoölogish Museum Amsterdam; BT: Tursch collection; DG: Greifeneder collection; JS: Senders collection; P.I.: Philippines; P.N.G. : Papua New Guinea.

Genus ***Agaronia*** Gray, 1839.
A. acuminata Lamark, 1811 (NIGERIA).

Genus ***Ancilla*** Lamarck, 1799.
A. lienardi Bernardi, 1858 (BRAZIL).

Genus ***Oliva*** Bruguière, 1789.
O. amethystina (Röding, 1798) (MARSHALL IS.: BT-2771; P.I.: BT-4563, 4564, 4567, 4570).
O. amethystina (Röding, 1798) forma *carnicolor* Dautzenberg, 1927 (P.I.: BT-1303, 1463, 3537, 4022, 4637).
O. arctata Marrat, 1871 (THAILAND: BT-081, 1232, 3490, DG-7102/6, DG-RWS-X).
O. australis Duclos, 1835 (AUSTRALIA: BT-1476, 1478, 3600, 4506, 5301).
O. baylei Petuch, 1979 (SOLOMONS: BT-725, 3548).
O. buelowi Sowerby, 1889 (P.N.G.: BT-399, 403, 422, 425, 426).
O. bulbiformis Duclos, 1840 (INDONESIA: BT-1549, 1551, JS-028, 029; P.I.: BT-1556).
O. bulbosa (Röding, 1798) (ABU DHABI: BT-4604, 4605, 4606, 4607, 4608).
O. caerulea (Röding, 1798) (MADAGASCAR: BT-4643, 4656; MOZAMBIQUE: BT-1194; SOUTH AFRICA: BT-2909, 2912).
O. caldania Duclos, 1835 (AUSTRALIA: BT-1610, 1612, 1614, 4442).
O. carneola (Gmelin, 1791) (SOLOMONS: BT-301, 2516, 2548, 2549, 2553).
O. carolinensis Conrad, 1863 (U.S.A., FLORIDA, Fossil: BT-3041, 3044, 3049, 3059, 3093).
O. caroliniana Duclos, 1840 (MOZAMBIQUE: BT-1567; SOUTH AFRICA: BT-2617, 2618, 3800, 3997).
O. ceramensis Schepman, 1904 (P.N.G.: BT-1577, 1582, 1601, 3562, 3563; SOLOMONS: BT-7196).
O. chrysoplecta Tursch & Greifeneder, 1989 (P.I.: BT-5005, 5511, 5512, 5514).
O. circinata Marrat, 1871 (BRAZIL: BT-1684, 1685, 2107, 2108, 2116, 2554, 5528, 6699, 6700).
O. concavospira Sowerby, 1914 (JAPAN: BT-5521, 5522; P.N.G.: BT-557, P.I.: BT-5279).
O. concinna Marrat, 1870 (P.N.G.: BT-7094, 7095, 7104, 7116, 7163).
O. dubia Schepman, 1904 (P.N.G.: BT-4928, 4929, 4930, 4931, 4932).
O. elegans Lamarck, 1811 (P.I.: BT-7225 to BT-7230).
O. esiodina Duclos, 1845 (TAHITI: BT-3688, 5298, 6042, 6046, 6048).
O. faba Marrat, 1867 (INDONESIA: BT-5385; SRI LANKA: BT-7197, 7198;THAILAND: BT-1330).
O. flammeacolor Petuch & Sargent, 1986 (SRI LANKA: BT-6220, 6221, 6222, 6224, 6225).
O. flamulata Lamarck, 1811 (GABON: BT-2087, 2088; MAURITANIA: BT-4215; SENEGAL: BT-2127, 4432).
O. foxi Stingley, 1984 (COCOS IS.: BT-3326, 5429).
O. fulgurator (Röding, 1798)(ARUBA: AM-10, 33, BT-1005; VENEZUELA: BT-2289, 2292).
O. funebralis Lamarck, 1811 (P.I.: BT-7218 to 7224). This is really a nomen nudum (see GREIFENEDER, DUCHAMPS & TURSCH, 1995). No replacement name yet selected. Name used here in its common, current acceptation.
O. hilli Petuch & Sargent, 1986 (TONGA: BT-5505, 5506, 5507, 5508, 6206).
O. hirasei Kira, 1959 (P.I.: BT-5021, 5022, 6202, 6194, 6196),
O. incrassata (Lightfoot in Solander, 1786) (W. MEXICO: BT-370, 371, 1664, 3235, 4135; W. PANAMA: BT-1018).
O. irisans Lamarck, 1811 (for this controversed name see GREIFENEDER, DUCHAMPS & TURSCH, 1995) (P.I.: BT-7203 to BT-7217).
O. julieta Duclos, 1840 (COSTA RICA: BT-735; W. MEXICO: BT-1663, 4129; W. PANAMA: BT-4130).
O. kaleontina Duclos, 1835 (GALAPAGOS: BT-4225; W. PANAMA: BT-3751, 3752, 3753, 3756).

O. lenhilli Petuch & Sargent, 1986 (P.I.: BT 7101, 7102).
O. leonardhilli Petuch & Sargent, 1986 (MADAGASCAR: BT-5515, 5516, 5706, 5707, 5708, 5709, 5710).
O. lignaria Marrat, 1868 (AUSTRALIA: BT-3206, 3207, 3208, 4831, 4832).
O. mantichora Duclos, 1840 (P.I.: BT-4534, 4540, 4544, 4545, 4546).
O. miniacea (Röding, 1798) (FIJI: BT-5184; MARSHALL: BT-2783, 2791; P.N.G.: BT-2783; TONGA: BT-026).
O. mucronata Marrat, 1871 (P.N.G.: BT-6510, 6512, 6515, 6516, 6522).
O. multiplicata Reeve, 1850 (TAIWAN: BT-660, 4257, 4629, 4260, 5463, 5466).
O. mustelina Lamarck, 1811 (HONG KONG: BT-6721; JAPAN: BT-4620; TAIWAN BT-4264; THAILAND: BT-2921, 2925).
O. neostina Duclos, 1840 (P.N.G.: BT-5016, 5017, 5018, 5019, 5020).
O. nigrita (Karsten, 1789) (Generally known as *O. vidua* (Röding, 1798), see TURSCH, DUCHAMPS & GREIFENEDER, 1994) (INDONESIA: BT-601; VANUATU: BT-610, 3312, 3313, 3314).
O. oblonga Marrat, 1870 (VENEZUELA: BT-970, 984, 2323, 6351, 6976).
O. oliva (Linné, 1758) (THAILAND: BT-1293, 1294, 1295, 1298).
O. olivacea (Karsten, 1789) (Generally known as *O. tesselata* Lamarck, 1811, see TURSCH, DUCHAMPS & GREIFENEDER, 1994)(P.I.: BT-4508, 4509, 4510, 4512, 4922).
O. panniculata Duclos, 1835 (JAPAN: BT-7172, 7173, 7174, 7275, 7176, 7177).
*O. parkinson*i Prior, 1975 (P.N.G.: BT-681; SOLOMONS: BT-2480, 2481, 2483, 2485).
O. paxillus Reeve, 1850 (HAWAII: BT-1928, 1931, 4316, 4318; SOLOMONS: BT-665)
O. peruviana Lamarck, 1811 (PERU: BT-353, 2235, 2236, 2237, 3000, 4281,).
O. polita Marrat, 1870 (MARQUESAS: BT-6051, 6054, 6055, 6056, 6057, 6058).
O. polpasta Duclos, 1840 (W. PANAMA: BT-3777, 3778, 3780, 3781, 3782).
O. ponderosa Duclos, 1840 (MALDIVES: BT-1199, 1200, 1954, 1955, 2326).
O. porphyria (Linné, 1758) (W. PANAMA: BT-3779, 3780, 3781, 3782, 3726).
O. reclusa Marrat, 1871 (ARUBA: AM-20, 21, 22, 25, 29).
O. reticularis Lamarck, 1811 (U.S.A., FLORIDA: BT-5537, 5539, 5541; E. PANAMA: BT-5616, 5617, 5618, 5619, 5620).
O. reticulata (Röding, 1798) (INDONESIA: BT-6715; P.N.G.: BT-451, 459; P.I.: BT-4596, 7231, 7132).
O. rubrolabiata Fischer, 1902 (VANUATU: BT-3493, 3494, 3959, 5011, 6676).
O. rufofulgurata Schepman, 1911. (P.I.: BT-4939, 4940, 4941, 4942, 4943; SOLOMONS: BT-3925).
O. rufula Duclos, 1840 (P.N.G.: BT-4599, 4600, 4601, 4602, 4603).
O. sayana Ravenel, 1834 (U.S.A., FLORIDA: BT-2410, 2793, 3113, 4077, 4084, 4100).
O. scripta Lamarck, 1811 (U.S.A., FLORIDA: BT-2154; HAITI: BT-2379; HONDURAS: BT-2756, 2757, 2762).
*O. semmelink*i Schepman, 1891 (P.N.G.: BT-792, 794, 795, 796, 797).
O. sericea (Röding, 1798) (INDONESIA: BT-006; 2052, 2053; JAPAN: BT-4048; TAIWAN: BT-4047).
O. sidelia Duclos, 1840 (MOZAMBIQUE: BT-2723; SEYCHELLES: BT-2707, 2708, 2710, 2714).
O. solomonensis Petuch & Sargent, 1986 (FIJI: BT-5228; P.I.: BT-5365, 5366; SOLOMONS: BT-2486, 2488).
O. spicata (Röding, 1798) (W. MEXICO: BT-334, 337, 4290, 5479, 5480, 5482; W. PANAMA: BT-2859, 3217, 3765, 3766, 3767, 3768, 3769, 3770, 4169).
O. splendidula Sowerby, 1825 (W. PANAMA: BT-946, 3736, 3741, 3746, 3749, 3750, 4023, 4024).
O. tigrina Lamarck, 1811 (MADAGASCAR: BT-1023, 1215, 4711; MOZAMBIQUE: BT-169; TANZANIA: BT-1240).
O. tricolor Lamarck, 1811 (INDONESIA: BT-4915, 4916, 5015, JS-027; P.I.: BT-6329).
O. undatella Lamarck, 1811 (ECUADOR: BT-2681; W. MEXICO: BT-331, BT-332; W. PANAMA: BT-1665, BT-1666).
"*O. vermiculata* Gray, 1858 " (auct.)(ARUBA: AM-48, 49, 51, 54, 56).
O. vicweei Recourt, 1989 (INDONESIA: BT-375, 2025).
O. zombia Petuch & Sargent, 1986 (HAITI: BT-5489, 5490, 5491, 5492, 5493).

Genus ***Olivancillaria*** Orbigny, 1840.
Olivancillaria urceus (Röding, 1798) (BRAZIL).

Genus ***Olivella*** Swainson, 1831.
Olivella biplicata Sowerby, 1825 (U.S.A., CALIFORNIA).
Olivella japonica Pilsbry, 1895 (JAPAN).
Olivella volutella Lamark, 1811 (W. PANAMA).

Incertae sedis:
"*Oliva*" *lacanientai* Greifeneder & Blöcher, 1985. (P.I.: BT-5045, BT-5046, BT-5047, BT-6025, BT-6026).

3. METHODS

3.1. Shell sections.

3.1.1. Cuts.

Shells were cut with a rotatory diamond blade along the 5 lines shown on Fig. 4, taking care to make the cuts as perpendicular to the surface as possible. The position of the cuts is approximative but the direction is not. The three longitudinal cuts follow the growth lines. The two transversal cuts are perpendicular to the lip. This yields the two fragments to be examined, a "***lip sample***" and a "***central sample***" (see Fig. 4).

3.1.2. Preparation.

Most often the samples can not be utilised as such, due to prominent traces of the cutting tool. The samples were hand-polished along each section to be examined, using wet carborundum grinding paste (grade 600) on a flat glass plate. In most instances the crystal structure is better seen after mild acid etching of the polished surface. Dyes (Fast Green or Brilliant Blue G) were occasionally utilised, to increase contrast.

3.1.3. Observation.

A binocular lens (WILD model M3 or 308700) was utilized at magnifications (10 x 40) or (10 x 80) to observe the arrangement of the layers and the orientation of the lamellae. Accurate drawings were made in each case with a WILD *camera lucida*.

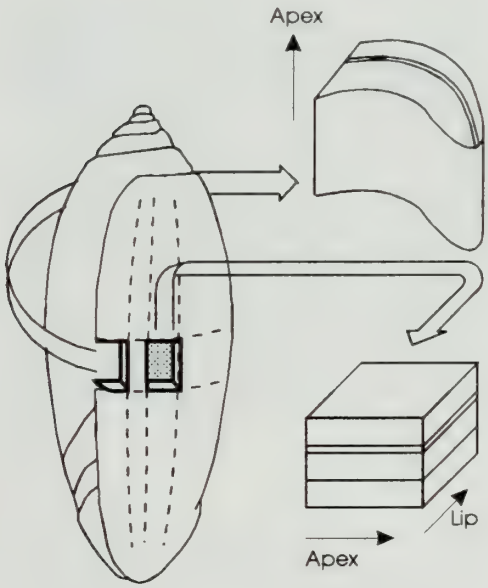

Figure 4. Shell sections. Upper right: "lip sample". Lower right : "central sample". Saw cuts indicated by dashed lines.

3.1.4. Representation.

Geometrical perfection of the crystal arrangements is seldom observed. In addition to natural curving and torsion of the lamellae (evidenced by electron microscopy, see below), deviations from ideality can also result from even small angular errors in the orientation of the cuts. Individual variations and age-related differences are also the rule, as fully expected. In spite of variation, many hundreds of observations have shown that the shell structures of Olividae fall into large, defined categories. This allows the use of schematic, idealised representations of these categories, instead of space-consuming, repetitive illustration of individual cases differing only in details. A few individual cases will be illustrated when needed.

Shell structures are complex, and easy comparisons can be made only if the samples are always orientated in the same way (see Fig. 4). "lip samples" seen slightly from above, looking from inside, with the edge of the lip vertical, at the right of the picture. We will always represent "central samples" looking towards the lip, with the direction of the apex at the right and with the external surface visible above. It can be seen that a 90° counterclockwise rotation of the "central sample" representation yields an image equivalent to a view of the hidden, vertical face of the "lip sample", seen from the left.

Only the orientation of the third order lamellae are sketched in the schematic representations.

3.2. Scanning Electron Microscopy (SEM).

For examination by scanning electron microscopy, shells were broken rather than cut. A thin (3-4 mm) slice of shell is first obtained by effectig two parallel cuts (longitudinal or transversal, according to the purpose), as described in § 3.1.1. This slice is then held in a vice and simply broken perpendicular to its length (by bending it with pliers). The sample is then coated with gold under vacuum, following the standard procedure.

3.3. Surface observations.

3.3.1. Difficulties.

The surface lamellae lie under a very thin, shining, translucid external pellicle (see below) and are most often not noticed on cursory examination. For most *Oliva* species, a tangent beam of light, directed along the direction of the crystals, makes them appear very clearly (a surprise for most students of *Oliva*). In many cases, and with some practice, the surface lamellae can easily be seen with a strong,

ordinary magnifying lens. Some species (such as *Oliva amethystina*) have a thicker external pellicle, impeding easy direct observation. Mild etching then solves the problem, the external pellicle being very sensitive to acid treatment. The surface lamellae at the internal face and at the edge of the lip are generally very easy to observe.

3.3.2. Observation.

A binocular lens (WILD model M3 or 308700) equipped with optic fiber lighting was utilized at magnifications (10 x 40) or (10 x 80) to observe the orientation of the lamellae at the surface of the external layer. The thickness **W** of the surface lamellae was estimated with a binocular lens (WILD 308700) at magnification (10 x 180), using a precalibrated ocular reticulum at right angle from the direction of the lamellae. One then counts the number of lamellae crossed by a predetermined 0.5 mm segment on the reticulum. The measurement is repeated 5 times and the mean value reported. Values differ vey little from reading to reading; measurement **W** is highly reproducible. Measurements effected on photomicrographs of known scale give essentially the same results. It should be stressed that **W**, as defined here, is really the thickness of the surface lamellae plus the thickness of the organic layer separating the lamellae.

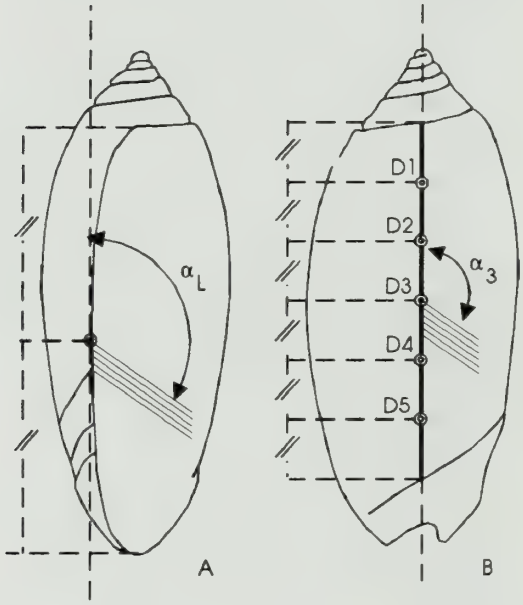

Figure 5. Surface lamellae. Angle measurements at mid-lip (**A**) and on dorsal region (**B**).

3.3.3. Position.

In order to obtain reproducible angular observations, one must examine the direction of the surface lamellae at specified positions. The midpoint of the lip (where the external pellicle is thinner) is often the easiest place for observing the surface lamellae. An accurate drawing of the lip edge and of the direction of the surface lamellae is made with the *camera lucida*. A tangent to the lip is then drawn and angle α_L is measured on the drawing as shown on Fig. 5A. In some species (for instance *O. rufula*) thickened longitudinal cords are present near the lip of mature specimens; in such cases α_L is measured just behind the cord, as close to the lip as possible.

Other angular measurements have also been effected at selected points of the dorsal side. The shell is laid on its ventral side, in its equilibrium position, immobilised with modelling clay. Under proper magnification and following a guideline in the ocular reticulum, a longitudinal reference line is then carefully drawn with a fine felt pen on the body whorl, as shown in Fig. 5B. Five points D1 to D5 are obtained by dividing in six equal segments the portion of the line joining the filament channel to the fasciole. For each point, an accurate drawing of both the longitudinal reference line and the direction of the surface lamellae is made with the *camera lucida*. At each point Di the corresponding angle α_i is determined as shown in the figure.

Angular measurements are reasonably fast (less than 10 minutes per specimen for all six measurements, much less for α_L and α_3 only). They are highly reproducible, as demonstrated in Table 1.

angle	mean	SD	CV
α_1	76.00°	2.00	2.63
α_2	78.83°	1.47	1.87
α_3	92.83°	1.17	1.26
α_4	119.33°	0.52	0.43
α_5	116.83°	2.64	2.26
α_L	95.17°	1.72	1.81

Table 1. Direction of the surface lamellae. Experimental error. Six independent series of measurements on the same shell (*O. sayana* BT-4077, H=63.17 mm). SD = standard deviation. CV = coefficient of variability (see text).

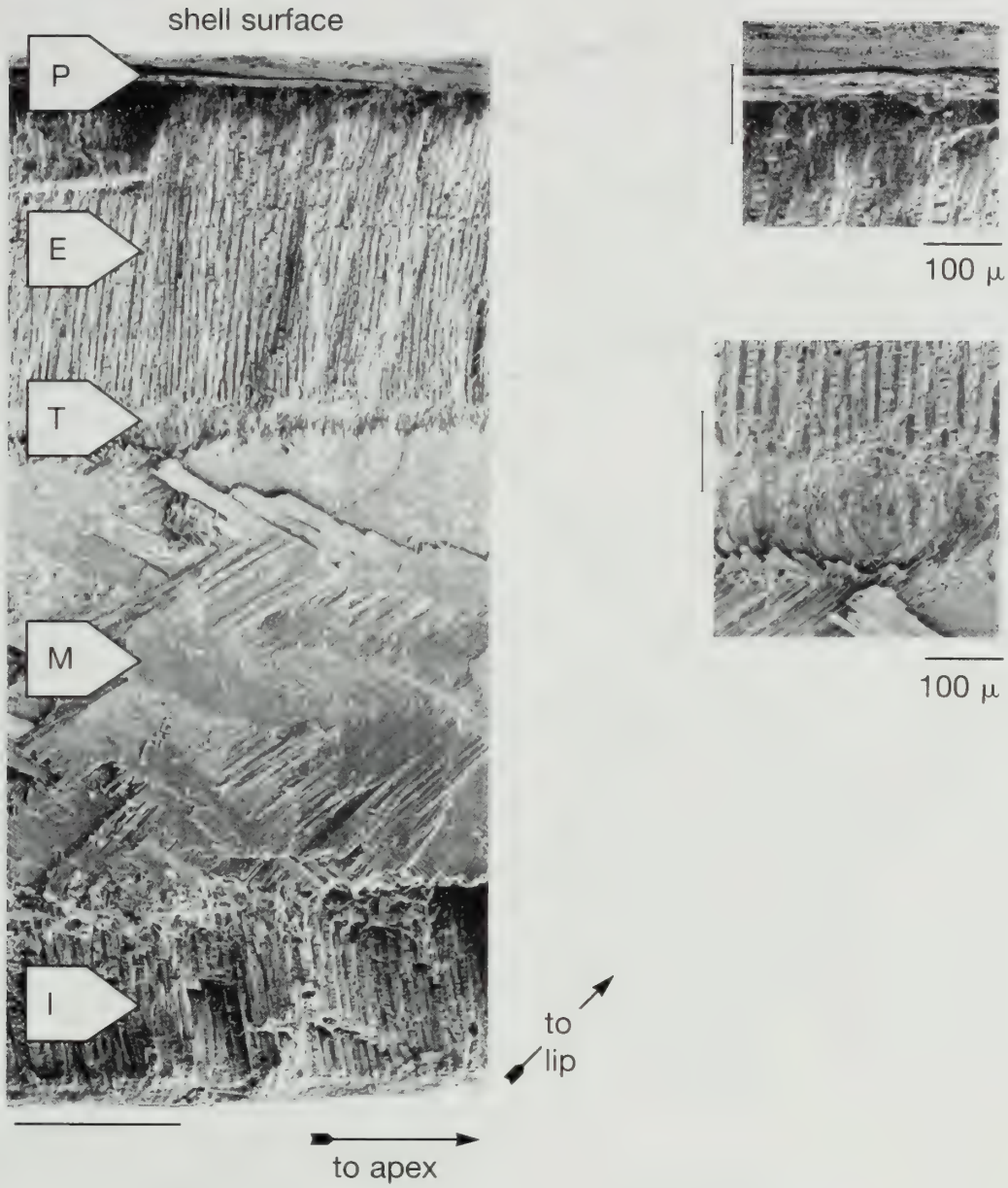

Plate 1. *Oliva reticulata*. Scanning electron micrography. Longitudinal section, seen towards the lip (apex at the right of the observer).

P: external pellicle. **E**: external XLM layer.
T: transition zone. **M**: middle XLM layer.
I: internal XLM layer.

4. RESULTS

4.1. The genus *Oliva*.

4.1.1. Observations on shell sections.

4.1.1.1. The components of the shell.

Oliva are devoid of periostracum. The structure of the shell is clearly evidenced by scanning electron microscopy (SEM). As an example, Plate 1 is a view of a longitudinal section of *O. reticulata*, seen looking towards the lip, with the apex of the shell at the right of the observer (the view sketched in Fig. 7B).

The shell of all the examined *Oliva* species consists of three XLM layers: the ***external, middle and internal XLM layers*** (respectively layers E, M and I, Plate 1). It can be seen that the layers have different directions.

Between the external and the middle XLM layers one always finds a thinner, intermediate zone, where the structure of the crystals is ill-defined (considerable twisting, torsion and disorientation, see § 1.2). This will be called the "***transition zone***" (Plate 1, T). No such transition zone has been observed between the middle (Plate 1, M) and the internal (Plate 1, I) XLM layers, that are in direct contact.

Above the external layer there is a thin, shiny, translucent ***external pellicle*** (Plate 1, P). For *O. sayana* this structure has been clearly depicted in a scanning electron micrograph by WILMOT *et al.* (1992: 26, Fig. 6a). In most cases, the external pellicle is very thin (roughly 5 to 10 μ, as in most species) and the lamellae at the surface of the external XLM layer can be easily seen by transparence. In some species (such as *O. amethystina*) the external pellicle can be much thicker (up to 80-100 μ); this may then conceal the lamellae at the surface.

Below the internal layer, an additional layer with no clearly defined crystal structure (this will be called the ***internal lining***) is occasionally observed for some species. This layer is mostly thin but can become important, especially in aged specimens. When present, it thins down towards the lip and ends before reaching the edge.

4.1.1.2. General observations.

Observation of a large series of shells (see section 2, Material) has shown that the above description is general. Variations have been observed both in the direction and the tilt of the lamellae. Noticeable variations of tilt have often been evidenced within the same species (and even within short distance on the same specimen). Measurements of tilt seem most unpromising for taxonomic applications. On the contrary, the direction of lamellae is remarkably constant within a given species, while exhibiting considerable differences between certain species (see Plate 2 for examples). These are precisely the qualities required for an operational taxonomic character.

Variations have also been observed in the relative tickness of the various XLM layers. These differences have a high intraspecific variability, often seem to be age-related and are also unpromising for taxonomic applications.

Most of the Indo-Pacific *Oliva* species fall into two groups of microstructure, examplified by *Oliva reticulata* and *O. amethystina*.

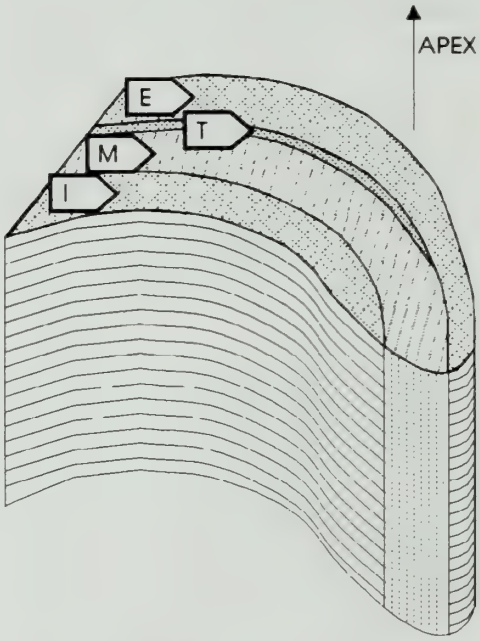

Figure 6. *Oliva reticulata*. Lip sample. Shell without internal lining. **P**: external pellicle. **E**: external XLM layer. **T**: transition zone. **M**: middle XLM layer. **I**: internal XLM layer.

4.1.1.3. Shell sections. *Oliva reticulata*.

Sections of the shell of this species are schematised in Figures 6 and 7. One can see that the direction of the lamellae of each of the three XLM layers is perpendicular to that of the lamellae of the neighbouring layer:

- The direction of the lamellae of the internal XLM layer (I) is nearly perpendicular to the lip.
- The direction of the lamellae of the middle XLM layer (M) is nearly parallel to the lip. Small variations of tilt make it appear either as in Fig. 7A or as in Fig. 7B (see § 1.2 and Fig. 3).

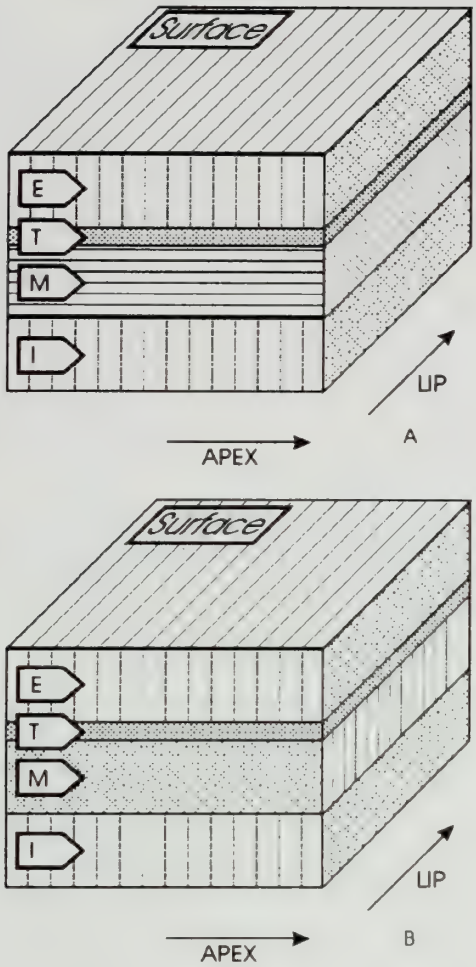

Figure 7. *Oliva reticulata*. Central sample. 7A and 7B differ only by the tilt of the middle XLM layer. **P**: external pellicle. **E**: external XLM layer. **T**: transition zone. **M**: middle XLM layer. **I**: internal XLM layer.

- The direction of the lamellae of the external XLM layer (E) is very nearly perpendicular to the lip.
- In aged specimens with a very thick lip, the transition zone (T) generally thins down and ends before the lip, so that the middle (M) and the external (E) XLM layers come into direct contact at the peristome. This can be seen (see Fig. 6) by direct observation of the edge of the lip. In younger specimens, the transition zone (T) mostly continues all the way to the lip, as shown for *O. amethystina* on Figs. 8A and 8B).
- The presence of an internal lining (not represented in Fig. 6, but appearing as for *O. amethystina* in Fig. 8A) is occasionally seen at some distance from the lip, especially in aged specimens.

A majority of Indo-Pacific *Oliva* species (see § 5.2) have this characteristic arrangement of XLM layers and form what will be refered to as the "***horizontal group***". This structure is also found in a few American taxa.

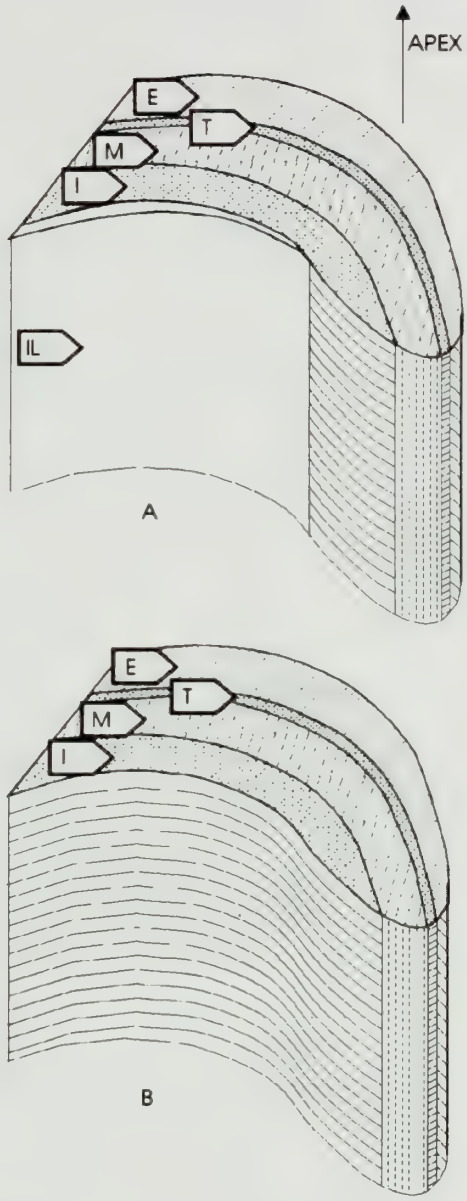

Figure 8. *Oliva amethystina*. Lip sample. A: shell with internal lining. B: shell without internal lining. **P**: external pellicle. **E**: external XLM layer. **T**: transition zone. **M**: middle XLM layer. **I**: internal XLM layer. **IL**: internal lining.

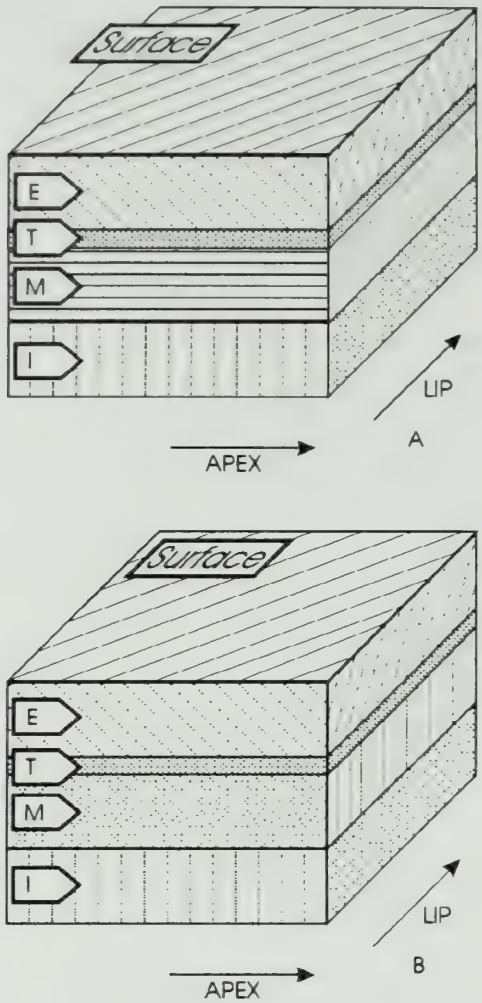

Figure 9. *Oliva amethystina*. Central sample. A and B differ only by the tilt of the middle XLM layer. **P**: external pellicle. **E**: external XLM layer. **T**: transition zone. **M**: middle XLM layer. **I**: internal XLM layer.

4.1.1.4. Shell sections. *Oliva amethystina.*

Sections of the shell of this species are schematised in Figures 8 and 9. (Figures 8A and 8B differ only by the presence of the internal lining, shown in Fig. 8A). One can see that the direction of the lamellae of only the internal and the middle XLM layers is perpendicular to each other:

- The direction of the lamellae of the internal XLM layer (I) is very nearly perpendicular to the lip (like in *O. reticulata*).
- The direction of the lamellae of the middle XLM layer (M) is very nearly parallel to the lip (like in *O. reticulata*). Small variations of tilt make it appear either as in Fig. 9A or as in Fig. 9B (see § 1.2 and Fig. 3).
- In contrast to *O. reticulata*, the direction of the lamellae of the external XLM layer (E) is markedly oblique to the lip.
- The extent of the transition zone (T) varies. In most specimens, it continues all the way to the lip, and can be directly observed of the edge of the lip (see Figs. 8A and 8B). This feature does not constitute a reliable taxonomic character: in aged specimens (with a very thick lip) the transition zone often ends before the edge of the lip (like in *O. reticulata*, see § 4.1.1.3. and Fig. 6). The presence of an internal lining (Fig. 8) is occasionally seen at some distance from the lip, especially in aged specimens.

A number of Indo-Pacific *Oliva* species (see § 5.2) have this characteristic arrangement of XLM layers and form what will be refered to as the "***oblique group***". This structure is also found in a few American taxa.

4.1.1.5. Exceptions.

Remarkable discontinuities in the enamel of the body whorl occur in the shell of two *Oliva* species: *O. undatella* Lamarck, 1811 (the type species of the subgenus *Strephonella* Dall, 1909) and *O. paxillus* Reeve, 1850 (the type species of the subgenus *Omogymna* von Martens, 1897). In these species the body whorl shows a discontinuity: it is divided by an oblique line into two sections of different structure. Examination of shell sections shows that in both cases, the external layer (E) and the transition zone (T) are present on the anterior (abapical) portion of the shell. The external layer (E) of both species belongs to the "oblique group" (see § 4.1.1.4).

- In *O. paxillus* (Fig. 10B) both the external layer (E) and the transistion zone (T) become gradually thinner (as if planed down) and generally terminate flush with the surface of the body whorl. The discontinuity line observed on the body whorl is the trace of the transition zone (T).
- In *O. undatella* (Fig. 10C) both the external layer (E) and the transistion zone (T) terminate abruptly. The observed discontinuity line corresponds to a sharp difference of levels on the body whorl.
- Another special case is that of the deep water "*Oliva*" *lacanientai* Greifeneder & Blöcher, 1985. In contrast to all other *Oliva* species, the shell (even when examined by electron scanning microscopy) has only two XLM layers (see discussion in section 4.4.).

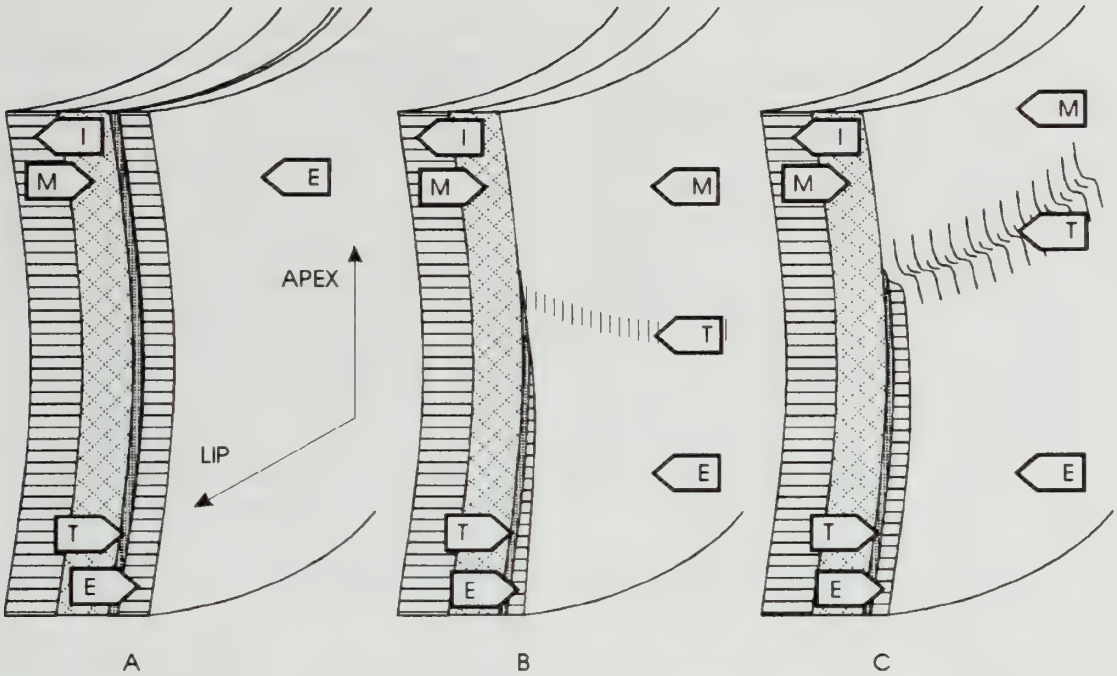

Figure 10. Particular cases. **A**: usual *Oliva* shell. **B**: *O. paxillus*. **C**: *O. undatella*.

4.1.1.6. Shell sections: Conclusions.

All the *Oliva* species examined so far share the same arrangement of the lamellae of the internal and the middle XLM layers (I and M). When species differ, it is mainly in the direction of the lamellae of the external XLM layer (E), which can be observed externally. So, in nearly all cases, the most relevant taxonomic information can be obtained without damaging the specimens.

4.1.2. Observation of shell surfaces.

The lamellae at the surface (see Plate 2) could be characterised by their shape, their length, their width and their direction.

4.1.2.1. Shape and length.

The shape and length of the lamellae varies from species to species. These might be useful indicative characters (despite of much intraspecific variability), but are quite difficult to quantify in a practical way. In addition, some "scrambled zones" with higher crystal disorder are occasionally seen in some shells of a few species.

4.1.2.2. Thickness.

The thickness (W) of the surface lamellae is easily measured, as described in § 3.3.2. Within a same species, W (measured at point D3, see § 3.3.3) has been shown to be correlated to the size of the shell (as shown for two species in Fig. 11). Large shells have wider lamellae (they could have had *more* lamellae).

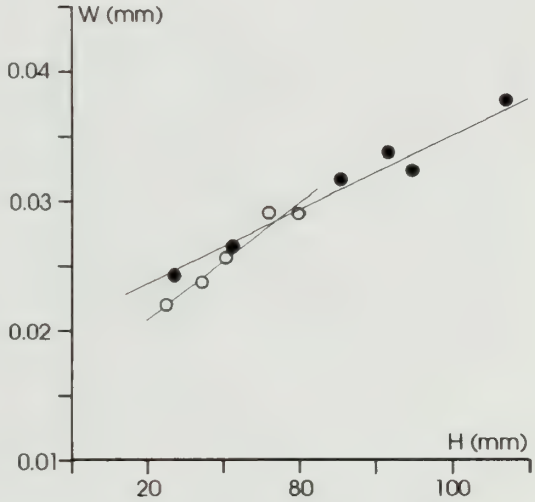

Figure 11. Thickness of surface lamellae (W, at point D3) *vs.* shell size (H). Black circles: *Oliva porphyria*. White circles: *Oliva lignaria*.

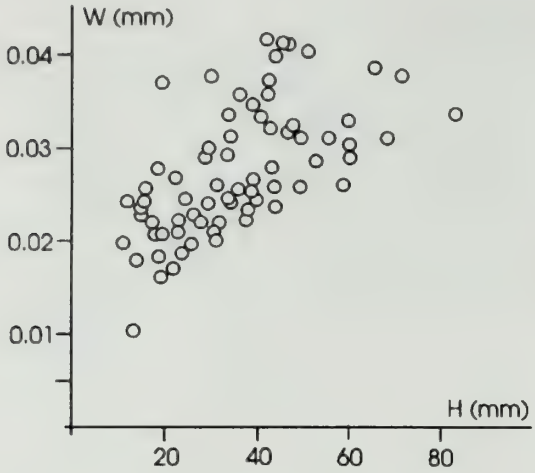

Figure 12. Thickness of surface lamellae (W, at point D3) *vs.* shell size (H). 73 *Oliva* taxa (see section 2, Material).

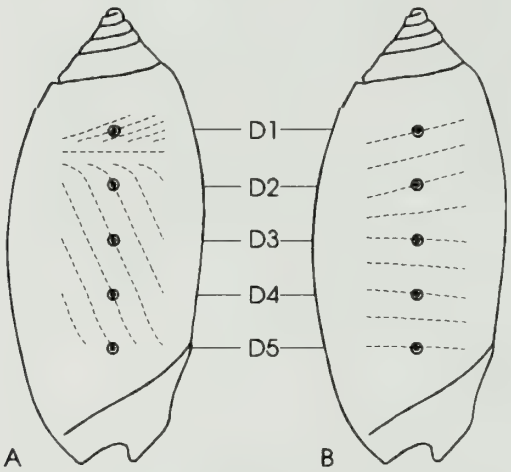

Figure 13. Examples of orientation of the surface lamellae. **A**: *Oliva splendidula*. **B**: *O. elegans*.

A scatter diagram of the thickness of the surface lamellae (W measured at point D3, see § 3.3.3) of 73 taxa of *Oliva* versus the length of the shell (H) is shown on Fig. 12. It can be seen that there is a general tendency for larger species to have thicker surface lamellae. There is much overlap and no clear cut groups emerge from the picture. In addition, the measurement W, even corrected for shell size, is quite variable in several species. In conclusion, W does not seem to constitute a promising taxonomic character.

4.1.2.3. Direction.

4.1.2.3.1. Generalities. The direction of the surface lamellae is very easily measured, as described in § 3.3.3. It can be seen (Fig. 13) that on the same shell, the direction of the surface lamellae varies regularly from point to point, hence the necessity of performing measurements at carefully determined points (see § 3.3.3 and Fig. 5). It can also be seen (Fig. 13) that the arrangement of the surface lamellae can differ very much from species to species.

For specimens of a same species, the direction of the surface lamellae (measured at the same point of the shell) displays (as expected) some individual variability but does not vary with shell size. An example on three species is given in Fig. 14 for the angle α_3, measured at point D3 (see § 3.3.3 and Fig. 5B).

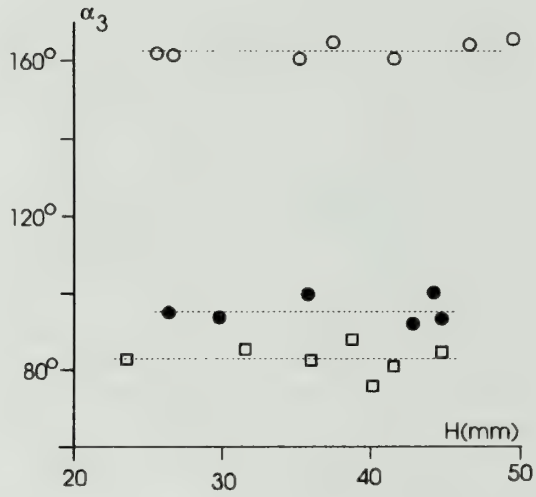

Figure 14. Direction of surface lamellae (α_3) *vs.* shell size (H). White circles: *Oliva splendidula*. Black circles: *O. peruviana*. White squares: *O. funebralis*.

4.1.2.3.2. Reliability of measurements. Both differences from species to species and independence from shell size suggest the potential of direction measurements as a taxonomic character for *Oliva* species.

The coefficient of variability (CV, the standard deviation expressed as a percentage of the mean) affords a comparison of the degree of variability in different species (MAYR, 1969). For seven of the nine species tested, the measurement α_3 has a CV lower than 4.5 %. This is comparable to the CV of many of the linear distance measurements utilised in *Oliva* taxonomy (see TURSCH & GERMAIN, 1985). For six out of the nine species tested, the measurement α_3 has a smaller CV than any

other dorsal angular measurement (see Table 2). The measurement α_L is slightly more variable than α_3 for seven out of the nine species tested. It presents the advantage of being very easy to determine.

The experimental error being quite small (see Table 1), the high CV values found for the two American species *O. sayana* and *O. reticularis* must reflect the specially high individual variability of these taxa.

The values of α_L , α_D and their coefficients of variability for 75 taxa in the genus *Oliva* are reported in Table 3.

4.2. Other genera in Olividae.

A preliminary inspection indicated that more variation in shell structure occurs in other molluscs of the family Olividae. Only the two inner XLM layers present in *Oliva* were seen in *Agaronia acuminata* Lamark, 1811 and *Olivella japonica* Pilsbry, 1895. *Olivancillaria urceus* (Röding, 1798), *Olivella volutella* Lamark, 1811 and *Olivella biplicata* Sowerby, 1825 had the three layers typical of *Oliva* but in contrast *Ancilla lienardi* Bernardi, 1858 has four layers, plus a well marked transition zone. A great number of species has to be examined and a separate, detailed investigation is clearly called for.

5. DISCUSSION.

5.1. Results.

The purpose of this study was to see if the structure of the shell could provide additional (and much needed) taxonomic characters for shells of the genus *Oliva*. The answer is positive: many *Oliva* taxa are separable on the basis of the direction of their surface lamellae.

The non-destructive measurements α_L and α_3 proposed here are fast (a few minutes) and reproducible (to less than 2%). Individual variation compares favourably with that of other measurements utilized in the genus: 71% of the taxa have a coefficient of variability smaller than 5% on α_L and 67% of the taxa have a coefficient of variability smaller than 5% on α_3. Rough estimations of α_L and α_3 can often be made even with a small hand lens.

The present study was limited to the central part of the body whorl, where the arrangement of the internal layers seems constant for all *Oliva* species. Other parts of the shell (the fasciole, the columella, the spire) have more complex structural arrangements and have not been described here. The shell structure of the body whorl of other genera in Olividae appears to be more varied than in *Oliva* and requires a separate investigation.

species	*n*		α_1	α_2	α_3	α_4	α_5	α_L
O. elegans	6	mean	75.5°	78.2°	89°	99.8°	98.8°	89.4°
		CV	3.48	4.55	3.63	7.19	12	3.87
O. funebralis	7	mean	78°	80.2°	83.9°	103°	103°	92.3°
		CV	8.13	5.44	4.45	9.64	6.18	3.11
O. irisans	15	mean	82.4°	80.2°	86.5°	95.2°	99.3°	88.9°
		CV	3.33	4.92	1.62	4.84	9.15	2.95
O. peruviana	6	mean	92.4°	86.5°	95.8°	103°	104°	105°
		CV	11.6	5	3.52	7.46	10.4	4.04
O. reticularis	12	mean	87°	87.6°	102°	116°	111°	133.5°
		CV	7.92	8.7	12.5	9.87	6.22	17.33
O. reticulata	6	mean	76.5°	76.8°	82.6°	95.6°	108°	89.7°
		CV	7.57	8.83	3.92	4.52	7.52	3.79
O. sayana	6	mean	74.6°	79.9°	92.8°	116°	116°	94.6°
		CV	6.99	7.62	10	9.38	7.49	11.69
O. splendidula	7	mean	89.8°	159°	163°	156°	140°	178.2°
		CV	17.4	4.05	1.34	3.53	10.1	4.2
O. tricolor	6	mean	76.9°	83.5°	86.9°	98.3°	102°	89.1°
		CV	5.05	5.23	3.69	1.94	11.6	5.19

Table 2. Direction of the surface lamellae. Individual variability. Measurements and their dispersion for nine *Oliva* species. SD = standard deviation. CV = coefficient of variability (see text).

species	loc	*n*	α_L (in °)		α_D (in °)	
			mean	CV	mean	CV
amethystina	IP	5	171.6	2.69	ns	x
arctata	IP	5	91	1.1	89.6	1.27
australis	IP	5	88	2.45	89.6	2.18
baileyi	IP	2	127	x	122.5	x
buelowi	IP	5	170.8	0.87	ns	x
bulbiformis	IP	5	86	3.39	82.4	4.08
bulbosa	IP	5	89.8	0.93	94	3.77
caerulea	IP	5	83	1.21	80.2	2.23
caldania	IP	5	82.8	2.32	83.2	3.93
carneola	IP	5	87	1.41	80.4	2.43
carnicolor	IP	5	165.6	2.16	ns	x
carolinensis (†)	WA	5	158	16.14	119	20.53
caroliniana	IP	5	88	2.27	88.8	2.44
ceramensis	IP	6	87.5	2.14	84.7	4.99
chrysoplecta	IP	4	164.8	2.29	161.5	2.6
circinata (|)	WA	5	114	8.84	99.6	7.19
concavospira (|)	IP	4	93.6	1.22	86.4	4.45
concinna	IP	5	89.6	1.27	85.6	3.17
dubia	IP	5	159.4	6.98	138.4	7.7
elegans	IP	6	89.4	3.87	89	3.63
esiodina	IP	5	181.2	1.58	164	3.57
faba	IP	4	90	0.91	84.25	4.48
flammeacolor	IP	5	92.2	2.7	89	1.12
flammulata	EA	5	90.8	0.49	88.8	1.67
foxi	EP	2	167	x	143.5	x
fulgurator	WA	5	132	2.89	119.4	5.82
funebralis	IP	7	92.3	3.11	83.9	4.45
hilli	IP	5	89.8	6.65	84.4	6.84
hirasei	IP	5	88	2.27	83.2	2.74
incrassata	EP	6	117	6.42	96.3	5.56
irisans	IP	15	88.9	2.95	86.5	1.62
julieta	EP	4	133.8	2.47	96.5	1.04
kaleontina	EP	5	82.2	4.5	74.8	4.91
lenhilli	IP	2	114.5	x	108.5	x
leonardhilli	IP	7	139	15.2	112	15.2
lignaria	IP	5	89.4	1	86	5.93
mantichora	IP	5	168.2	7.44	135.7	4.74

species	loc	*n*	α_L (in °)		α_D (in °)	
			mean	CV	mean	CV
miniacea	IP	5	93.2	2.98	89.6	3.01
mucronata	IP	5	101.6	6.01	85.8	4.62
multiplicata	IP	6	145	15.5	109	13.2
mustelina (|)	IP	5	90.8	1.44	86.4	2.67
neostina	IP	5	91.2	2.94	86	0.82
nigrita	IP	5	92	3.84	89.8	2.66
oblonga	WA	5	136	11.27	121.2	6.58
oliva	IP	4	84.75	3.78	82.25	0.61
olivacea	IP	5	89	2.1	83.6	4.36
panniculata	IP	6	174	4.5	95.3	4.43
parkinsoni	IP	5	166.6	6.52	ns	x
paxillus	IP	5	159.8	4.67	155	7.51
peruviana	EP	6	105	4.04	95.8	3.52
polita	IP	6	177.5	2.25	165	3.04
polpasta	EP	5	75.8	9.25	82.6	5.59
ponderosa	IP	5	92.4	2.82	89.4	3.76
porphyria (|)	EP	5	114.2	3.68	108.2	3.83
reclusa	WA	5	103.6	3.25	102.6	4.17
reticularis	WA	5	136	5.12	114.2	6.3
reticulata	IP	6	89.7	3.79	82.6	3.92
rubrolabiata (|)	IP	5	95.6	1.75	87.8	1.25
rufofulgurata (|)	IP	5	178	2.33	142.5	3.91
rufula (|)	IP	5	91.6	1.25	81.6	7.28
sayana	WA	6	94.6	11.69	92.8	10
scripta (|)	WA	5	98.4	4.8	87	4.3
semmelinki	IP	5	162.2	3.09	160	3.67
sericea	IP	5	92.8	2.99	85.2	4.27
sidelia	IP	5	90.6	0.99	84.4	2.73
solomonensis	IP	5	89.4	1.27	84.8	2.11
spicata	EP	15	146	10.39	118	12.8
splendidula	EP	8	178.2	4.2	163	1.34
tigrina (|)	IP	5	93	2.28	88.6	3.71
tricolor	IP	6	89.1	5.19	86.9	3.69
vermiculata	WA	5	132.4	11.51	106	5.62
vicweeei	IP	2	87	x	80	x
zombia	WA	5	138.6	5.29	109	5.98

Table 3. Direction of the surface lamellae of *Oliva* taxa. Measurements α_L, α_D and their coefficient of variability (CV). EA: East Atlantic; EP: East Pacific; IP: Indo-Pacific; WA: West Atlantic. Symbols: (|): cords at lip, see text § 3.3.3. (†): fossil species. ns: not seen.

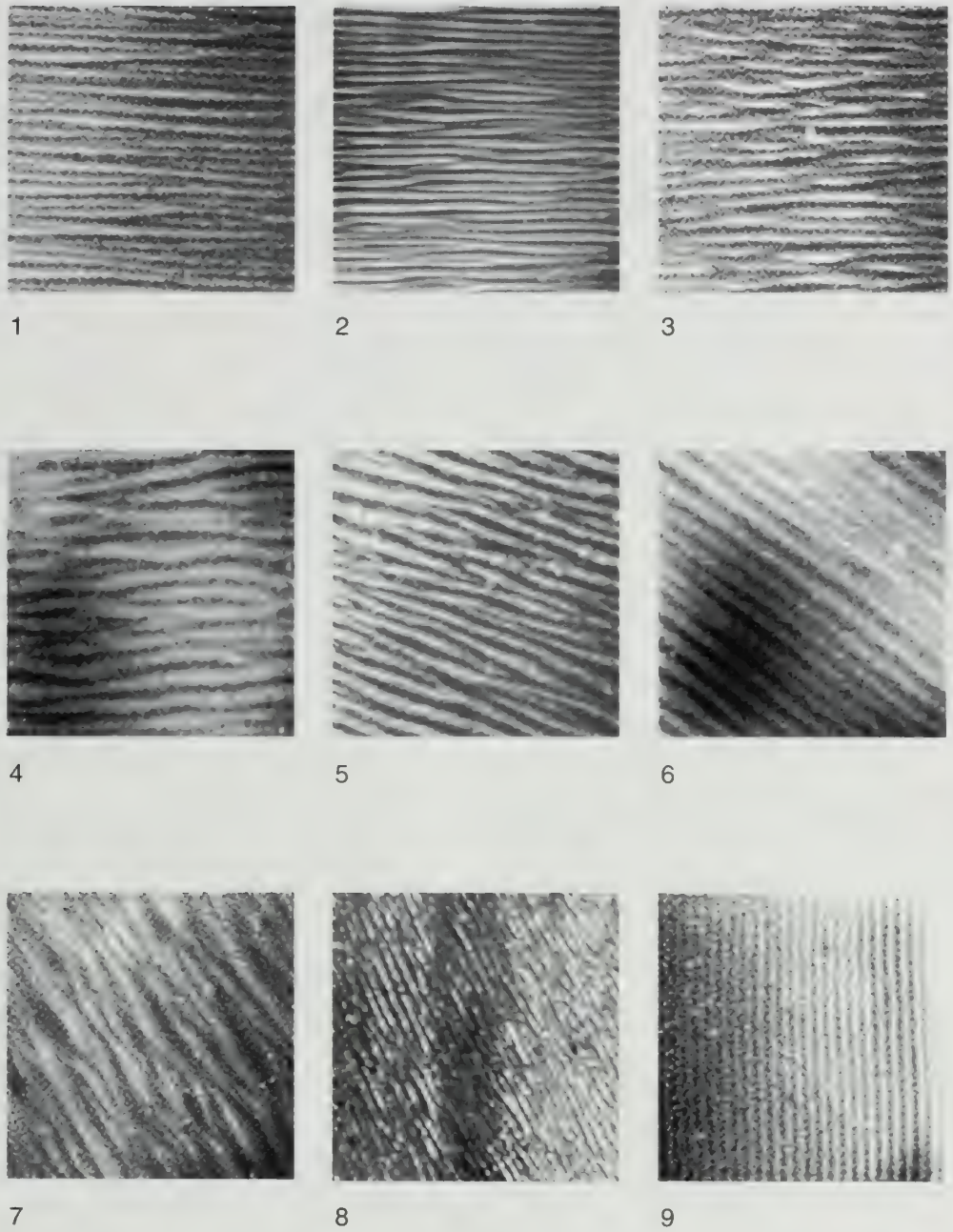

Plate 2. Surface lamellae at mid-body whorl (x 64). Axis of shell: vertical. **1**: *O. concavospira* (H: 36.03 mm).**2**: *0. funebralis* (H: 26.23 mm). **3**: *0. rufula* (H: 30.02 mm). **4**: *0. kaleontina* (H: 30.40 mm).**5**: *0. peruviana* (H: 43.27 mm). **6**: *0. polpasta* (H: 36.17 mm). **7**: *0. amethystina* (H: 42.21 mm). **8**: *0. multiplicata* (H: 42.94 mm). **9**: *0. semmelinki* (H: 15.75 mm).

	n	α_L	α_3
O. spicata (W. Mexico)	6	132.2 (CV=6.82)	106.7 (CV=6.54)
O. spicata (W. Panama)	9	156.3 (CV=7.18)	126.3 (CV=11.15)

Table 4. Geographic variation in the direction of the surface lamellae. *O. spicata* from W. Mexico and from W. Panama. Measurements α_L, α_D and coefficient of variability (CV).

In many cases, the direction of the surface crystals of *Oliva* species seems to reflect taxonomic affinities. For instance, all the examined Indo-Pacific species that have been placed in the subgenus *Annulatoliva* Petuch & Sargent, 1986 (*O. amethystina, O. buelowi, O. carnicolor, O. parkinsoni*) have α_L values in the range 165-172°. In contrast, all the examined species that have been grouped in the subgenus *Miniaceoliva* Petuch & Sargent, 1986 (*O. flammeacolor, O. hirasei, O. lignaria, O. miniacea, O. ponderosa, O. sericea*) have α_L values in the very distinct range 83-94°. But in some other Indo-Pacific groups, this character does not appear to reflect phylogeny and the direction of surface crystals differs greatly between very closely related taxa. This is the case for *O. australis* (α_L = 88) and *O. leonardhilli* (α_L = 139). In the case of *O. panniculata* (α_L = 174, α_3 = 95.3) and *O. polita* (α_L = 177.5, α_3 = 165), the values are in close agreement for α_L but are widely divergent for α_3.

Small differences in crystal direction should be interpreted with great caution. Individual variation is quite large (CV over 10%) in a few species and in addition, geographic variation has been detected in some cases, for instance in *O. spicata* (see Table 4).

5.2. Trends.

The frequency distribution of the easiest measurement, α_L, is quite peculiar. Analysis of the data of Table 3 show (Fig. 15) that the Indo-Pacific *Oliva* taxa have a distinctly bimodal α_L distribution: the great majority unmistakably belong either to the "horizontal" or to the "oblique" group. Only 4 taxa (of rather peculiar lineages) occupy intermediate values. These are *O. lenhilli* (α_L = 114.5), *O. baileyi* (α_L = 127), *O. leonardhilli* (α_L = 139) and *O. multiplicata* (α_L = 145).

In contrast, the American taxa (Fig. 16) (the closely related Western Atlantic and Eastern Pacific *Oliva* faunas are here considered together) have a regular, monotonous distribution that is centered on the intermediate values of α_L rarely observed for Indo-Pacific taxa). Indeed 61% of the American taxa are in the 105-150° range, where only 8% of the Indo-Pacific taxa do occur.

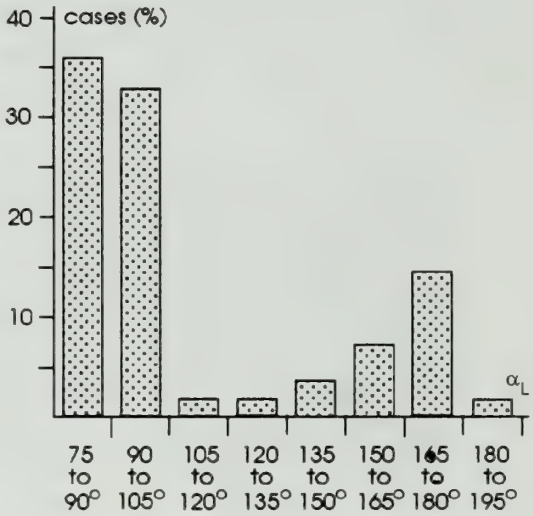

Figure 15 . 53 Indo-Pacific *Oliva* taxa. Direction of surface lamellae. Histogram: distribution of α_L .

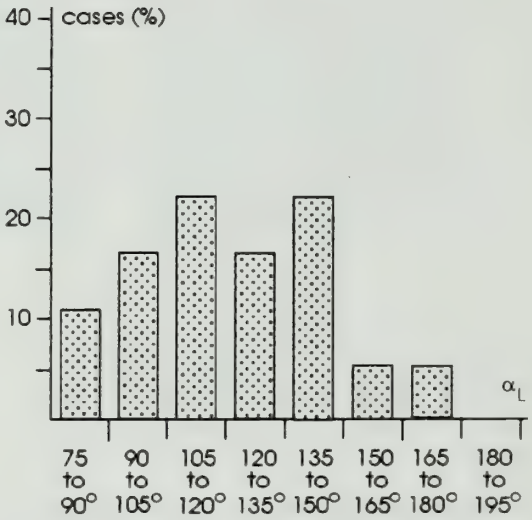

Figure 16. 19 American *Oliva* taxa. Direction of surface lamellae. Histogram: distribution of α_L .

5.3. Interpretation.

The "oblique" structure found in some American species certainly contitutes an old character, probably antedating the closing of the Panama isthmus and the separation of the Western Atlantic and the Eastern Pacific faunas, as this feature is already strongly marked (α_L = 158) in the fossil *O. carolinensis* (from the Caloosahatchee Formation). At first sight, the comparison of figures 15 and 16 (two separate groups opposed to one very variable group) evokes a case of evolution by disruptive selection (see for instance FUTUYMA, 1986: 154), suggesting that the Indo-Pacific *Oliva* species could derive from an ancestral American stock.

Such an interpretation should still be considered with much circumspection, as the data could as well (and possibly better) be interpreted in terms of adaptation. The direction of the surface crystals probably influences the mechanical resistance of the shell (as shown by CURREY, 1990 cited in VERMEIJ, 1993). Mollusc-eating crustaceans are larger, more powerful and better armed in the Indo-Pacific region than in the Western Atlantic (VERMEIJ, 1978), resulting in the general development of more efficient shell armour in the Indo-Pacific (VERMEIJ, 1993). It is thus plausible that the Indo-Pacific *Oliva* would be selected for the shell structures offering maximal resistance, while the American taxa (with the exception of *O. porphyria, O. kaleontina* and *O. splendidula,* all are very closely related and grouped in the genus *Strephona* Mörch, 1852) could afford to display a wide range of variation. But we have no experimental data so far on such a correlation between shell microstructure and mechanical resistance in *Oliva* (this should ideally be demonstrated on shells differing *only* in the orientation of surface lamellae).

The difference in frequency distribution reported here is not the only character differentiating the American and the Indo-Pacific *Oliva* faunas. A rather similar (but inverted) situation has already been reported (TURSCH, 1988) for protoconch characters: here the American taxa display a very large range of variation while the Indo-Pacific taxa are concentrated in a narrow, central range. Extreme variability in several shell characters and conservatism in colour patterns seem to be the hallmark of many American *Oliva* species.

5.4. The case of "*Oliva*" *lacanientai.*

It has been mentioned (in section 4.1.1.5.) that the deep water "*Oliva*" *lacanientai* Greifeneder & Blöcher, 1985 has only two XLM layers, in contrast to the three layers present in all other *Oliva* species that we have examined. In the original description, the authors have underlined that its "subgeneric status is doubtful" and concluded that this species "is not closely related to any species of Olividae known so far". This additional evidence reinforces their doubts. In our opinion, it constitutes a strong evidence that the species does not belong to the genus *Oliva* and should be classified in a separate genus. Such a step should preferably be taken only after the soft parts of the animal could be studied.

ACKNOWLEDGEMENTS.

This study was suggested to us by Dr. D. Greifeneder who was the first (as in many other instances) to notice differences in the shell microstructure of *Oliva* species. We thank Prof. L. Devos (Université Libre de Bruxelles, Animal Biology) for help with scanning electron microscopy and Dr. Y. Finet (Musée d'Histoire Naturelle, Geneva) for useful references. We thank Mr. G. Bernardinis (Université Libre de Bruxelles, Geology) for his kind help in preparing shell sections. We are grateful to Prof. H. Coomans (Zoölogisch Museum, Amsterdam), Dr. D. Greifeneder, Dr. J. Senders and Mr. G. Poppe for the loan of specimens.

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Contribution to the knowledge of the family Caecidae. 2. *Caecum auriculatum* de Folin, 1868 (Caenogastropoda: Rissooidea) (*)

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KEYWORDS: *Caecum, Brochina*, meiobenthic, North East Atlantic, Recent, marine, lectotype.

ABSTRACT. The complex of forms related to *Caecum auriculatum* de Folin are reviewed. The synonymy of *C. auriculatum* is discussed after examination of types and large additional material. The status of the taxon *Brochina decurtata* Monterosato is discussed, with consideration on the biological implications. Two forms of this complex are additionally considered.

INTRODUCTION

The European species of the family Caecidae Gray M.E., 1850 have been the object of many important works during recent years, mainly by Dutch authors (e.g. VAN AARTSEN & FEHR-DE WAL, 1975; VAN AARTSEN, 1977; VAN AARTSEN & HOENSELAAR, 1984; VAN DER LINDEN, 1986; HOEKSEMA & SEGERS, 1993). Despite such an array of studies, we consider it useful to deal with an allegedly well-known Mediterranean species, such as *Caecum auriculatum* de Folin, 1868 and related forms. The aim is to provide a new insight, with new data based on the large amount of material we have examined.

SYSTEMATICS

Superfamily RISSOOIDEA
Gray J.E., 1847
Family CAECIDAE Gray M.E., 1850
Genus *Caecum* Fleming, 1813

***Caecum auriculatum* de Folin, 1868**
Figs. 1-17
= ? *Odontidium laevissimum* Cantraine, 1842
= *Brochina chiereghiniana* Brusina, 1869
= *Caecum syriacum* de Folin, 1869

= *Brochina decurtata* Monterosato, 1884
= *Caecum vitreum* sensu Vaissière, 1930 not Carpenter, 1858
= *Caecum saavedrae* Beltran, 1965
= *Dentalium glabrum* sensu authors not (Montagu, 1803)

Original description (DE FOLIN, 1868: 95).

"Testa irregulariter elevata, interdum lata, cylindrica, paulo arcuata; subdiaphana, nitida, minutissime transversim striata; aperturam versus annulo parum expresso, lato, planato, tumescente; apertura vix declivi, haud

(*) Contribution 1 was published in *Apex*, 9(2/3): 79-82. Work partly supported by CNR (Comitato Ambiente) funds.

contracta, subacuta. Septo mamillato, seu hemispherico, prominente; apice dextrorso lato, auriculato; margine laterali et dorsali in uno, convexo, semi-circulari; operculo ? Long.: 0,0023; diam.: 0,0006."

Material examined

Type material - *C. auriculatum*: holotype (MNHN, Paris). A plastic box containing two glass vials is stored in the MNHN (Paris) :

Vial 1 - One partly broken shell (1.85 mm, Fig. 1), cracked, with the surface eroded and with traces of glue. The accompanying label reads: "*Caecum auriculatum* de Folin 1868. HOLOTYPE figuré probable F. M. I pl.XI f. 2 - 3". This is very likely to be the holotype, and has been identified by Virginie Heros (MNHN) who wrote the label (S. Gofas pers. comm.). In facts, de Folin states he has received a single specimen ("Notre type est ..."), from Palermo. Three original (by de Folin hand) labels have been kept in the box (Figs. 2-4): two of them report the name of the species with the notation "lisses" by which the author indicated the group of smooth (no sculpture) *Caecum* (Figs. 2, 3). The third label bears only the indication "Palerme. Carlo-forte." (Fig. 4).

Vial 2 - Eight shells with traces of glue, labelled simply "ex. auteur.". They can not be considered as types, since they are not mentioned in the original description, and are likely to originate from the second locality of the third label (namely Carlo Forte, S. Pietro Is., Sardinia, Italy). Anyway, they fit exactly *C. auriculatum* as commonly known.

C. syriacum: holotype (MNHN, Paris: Figs. 7-9). *Brochina decurtata*: lectotype (here selected; GAGLINI, 1991: 132, fig. 122) and paralectotype, from Palermo (MZR, Rome).

Additional material - Some thousands specimens and shells from all over the species range. Particularly, of the form *decurtatum* Monts. (see below) we have examined the following material:

SINGLE-RING FORM - Civitavecchia (Rome, Italy), sediment in a glass bottle, -3 m, 1 shell; Capriccioli (SS, Italy), -1.5 m, 2 shells; Is. La Maddalena (SS, Italy), -4 m, 1 shell; Piccolo Romazzino (SS, Italy), -3/4 m, 1 shell; Capo Palinuro (SA, Italy), "Occhi" cave, -9 m, 5 shells; Isola delle Correnti (SR, Italy), -1.5 m, 8 shells; Punta de Nana (Granada, Spain), -17 m, 2 shells; Cerro Gardo (Granada, Spain), -21 m, 1 shell; Umago (Istria), beached, 1 shell; Zakynthos Is. (Greece), 1 shell.

DOUBLE-RING FORM - Civitavecchia (Rome, Italy), sediment in a glass bottle, -3 m, 1 shell; Santa Marinella (Rome, Italy), beached, 1 shell; Isola delle Correnti (SR, Italy), -1.5 m, 1 shell; Cala Calandra (Lampedusa Is., Italy: URANIA'91 Expedition), -30 m, 30.IV.1991, 1 shell; Punta de Nana (Granada, Spain), - 17 m, 1 shell; Kash (Southern Turkey; AKDENIZ'92 Expedition stn. AKD 92.15), -28 m, 1 shell.

Type locality

Palermo (Italy), by original designation.

Distribution

All over the Mediterranean Sea, very common; it has been recorded in the Atlantic waters (Linden, 1986). Living specimens have been collected in soft bottoms (fine to coarse sediment) from a very few meters to 50 m depth. Ruggieri (1994) reported for the first time material of this lineage from the Pliocene and Pleistocene of Sicily.

Subsequent description

Adult stage: shell small, white, transparent in beached specimens, with a light brownish periostracum; such ephemeral periostracum has sometimes very weak longitudinal wrinkles, slightly undulated, They are visible only at high magnification and recall the encrusting tubes of some polychaetes.

The tube is regularly cylindrical, moderately arched [*]; surface smooth, with no longitudinal sculpture, with only very weak growth lines. Septum hemispheric, more or less protruding, with hear-like mucro, right orientated (Fig. 14).

Latero-dorsal margin convex, semicircular. Ventral margin concave. Aperture circular, ringed, bent toward the ventral margin.

Dimensions: maximum length is ca 2 mm (adult stage).

Growth stages: all stages have been identified, with the exception of the larval one. For the latter, we have been unable to score unequivocal characters for the identification (such as the microsculpture used by HOENSELAAR & HOENSELAAR (1990) for *C. trachea*). The characters of the species are identifiable also in the juveniles, that are slightly different: (i.e.) the septum is more nail-shaped, and recalls that of *C. trachea*, the apertural ring is lacking, and the general silhouette (nearly cylindrical in the adult) is slightly conical (Fig. 6).

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[*] *Caecum auriculatum* has a tube less curved than *C. lightfootae* Pizzini, Nofroni & Oliverio, contrary to what erroneously written in PIZZINI *et al.* (1994: 80).

Operculum: perfectly circular, corneous, light brownish, with concentric ridges on the outer side, and numerous radial zigzag lines on the inner side (Figs. 15-17).

Besides CARPENTER (1859) on the one side, who lapidary described the opercula of some species in the frame of a simple scheme, and BARTSCH (1920) on the other side, who used it as a fundamental character in his key, the operculum has been largely disregarded by most of the authors. For example, DE FOLIN (1868-1869: 260) contested the validity of the degree of convexity of the operculum as a good character, as used by Carpenter and Bartsch.

In *C. auriculatum,* the operculum is very peculiar. At our knowledge. within the Mediterranean Caecidae, it is the only case of an operculum sculptured on both sides.

Animal: PANETTA (1980) examined the soft parts of *C. auriculatum* and found them to be similar to those of *C. glabrum* (see GÖTZE, 1938).

Remarks

The holotype (Fig. 1) has a septum with a particularly protruding mucro, a character exceptional in *Caecum auriculatum*. All other features fit well with the description of *C. auriculatum* and we believe this is a somehow anomalous specimen, certainly belonging to the present species, as currently known.

C. auriculatum differs from *C. armoricum*, lacking any microsculpture on the tube, having a less projecting septum, and a ringed aperture (the latter is a character valid only for the full grown adult stage).

C. subannulatum has a more slender profile, a normally smaller size and the septum always perfectly hemispheric, without any appendage, even in juveniles.

Nearly all modern authors agree considering *Brochina decurtata* Monterosato, 1884 as a synonym of *C. auriculatum*. We completely adhere to this interpretation, and present here further support to it. Based on Lower Pleistocene material from M. Serro (Trapani, Sicily, Italy), RUGGIERI (1994), excludes the possibility that injuries caused the 'shortening' of the shells, a position that we share; rather, he proposes to explain the existence of the 'monstrosity' *decurtatum* with events of autotomy by the very snails. According to our material, we consider very unlikely this explanation. Besides many 'short' shells (see Material examined: Fig. 13), we have found six adult shells of *C. auriculatum* with two rings (Fig.12): the first varix at the middle of the shell length (corresponding to the apertural varix of the 'short' shells; in one shell the first varix was more close to the septum), and the second at the aperture. This phenomenon can be explained if we consider that a varix is normally formed in gastropods when sexual maturity is reached or when gonads are mature (FRETTER & GRAHAM, 1962; see GOSTAN, 1958 for an example in rissooideans). Probably, some individuals (form '*decurtatum*') reach maturity earlier than others, and only after that some of them start newly to grow. This possibility is somehow also considered by PALAZZI (1979: 62). The tube formed after the first varix has often a subconical (not cylindrical) shape (Figs. 10-12). The septum of the form '*decurtatum*', supposed to be more protruding and rounded according to the original description, is not a diagnostic character as suggested (GAGLINI, 1991). According to our material (we select here the specimen figured by GAGLINI, 1991: 132 fig.122 as lectotype of *B. decurtata*) and to RUGGIERI (1994), there is a wide variation well within the range of 'normal' *C. auriculatum*.

According to the original description and illustration (BELTRAN, 1965), *C. saavedrae* is a junior synonym of *Brochina decurtata* Monterosato, 1884 (and therefore of *C. auriculatum*). Several other taxa (e.g. *C. breve* de Folin, 1867 from the West Atlantic, and *C. abnormale* (Carpenter, 1857) from the Panamic Province), are very likely to be based on short forms of other known species (studies are in progress by the first author, M.P.), a possibility already suggested by CARPENTER (1957) himself, and LIGHTFOOT (1993).

The holotype of *C. syriacum* de Folin, 1869 (MNHN, Paris), has been already figured by PANETTA (1980). This specimen (Fig. 7) is a juvenile at the third stage. *C. syriacum* is a synonym of *C. auriculatum*, as already suggested by PANETTA (1980) and VAN AARTSEN (1977).

In his first works, Monterosato used the name *Odontidium laevissimum* Cantraine, 1842 as a senior synonym of *C. auriculatum*; subsequently, he started using the name *auriculatum*. VAN AARTSEN (1977) regards *O. laevissimum* as a nomen dubium, since the taxon is not recognizable and the whereabouts of the original material is unknown.

With the sole exception of SCHIRÒ *et al.* (1976: 17) who adopted a subgeneric classification for the Mediterranean species, all modern European authors use a simplified classification of Caecidae, with the sole genera *Caecum* and *Parastrophia*. On the other hand,

the American authors usually employ a more articulated (sub)generic subdivision. Lacking sufficient information on the anatomy and relationships within the family, we refrain from using an articulated (sub)generic system, and prefer a more conservative position. Anyway, it should be noted that *Caecum auriculatum* has been classified by some past authors in the supraspecific taxon *Brochina*, together with some extramediterranean species.

Caecum sp. A

Figs. 18-21

Material examined:

Capo Palinuro (Salerno, Italy), sediment inside 'Occhi' cave, -6 m, 2 shells; Pantelleria Is. (Agrigento, Italy: URANIA'91 Expedition), -31 m, 1 shell; Sardinia (Italy), beached, 2 shells, G. Zanardi leg.; Agropoli (Salerno, Italy), beached, 1 shell, K. Nicolay leg.

Remarks

We have sorted out specimens of a *Caecum* similar to *C. auriculatum* in the septum, mucro, tube and apertural ring (Figs. 18-20). These specimens are characterised by a peculiar sculpture of longitudinal, parallel and equidistant series of pits (Fig. 21). We refrain from describing a new species based only on such a character, waiting for more material to define its value.

Caecum sp. B

Material examined:

Salvore (Croazia), several specimens, beached material, D. Di Massa leg.

Remarks

This entity is nearly identical to *C. auriculatum* in all features, but the size. All examined specimens are ca one third to half the size of 'normal' *C. auriculatum*. The adult features of such specimens (e.g. cylindrical tube) would prevent us to consider them as juveniles. Their status is currently being investigated by the authors.

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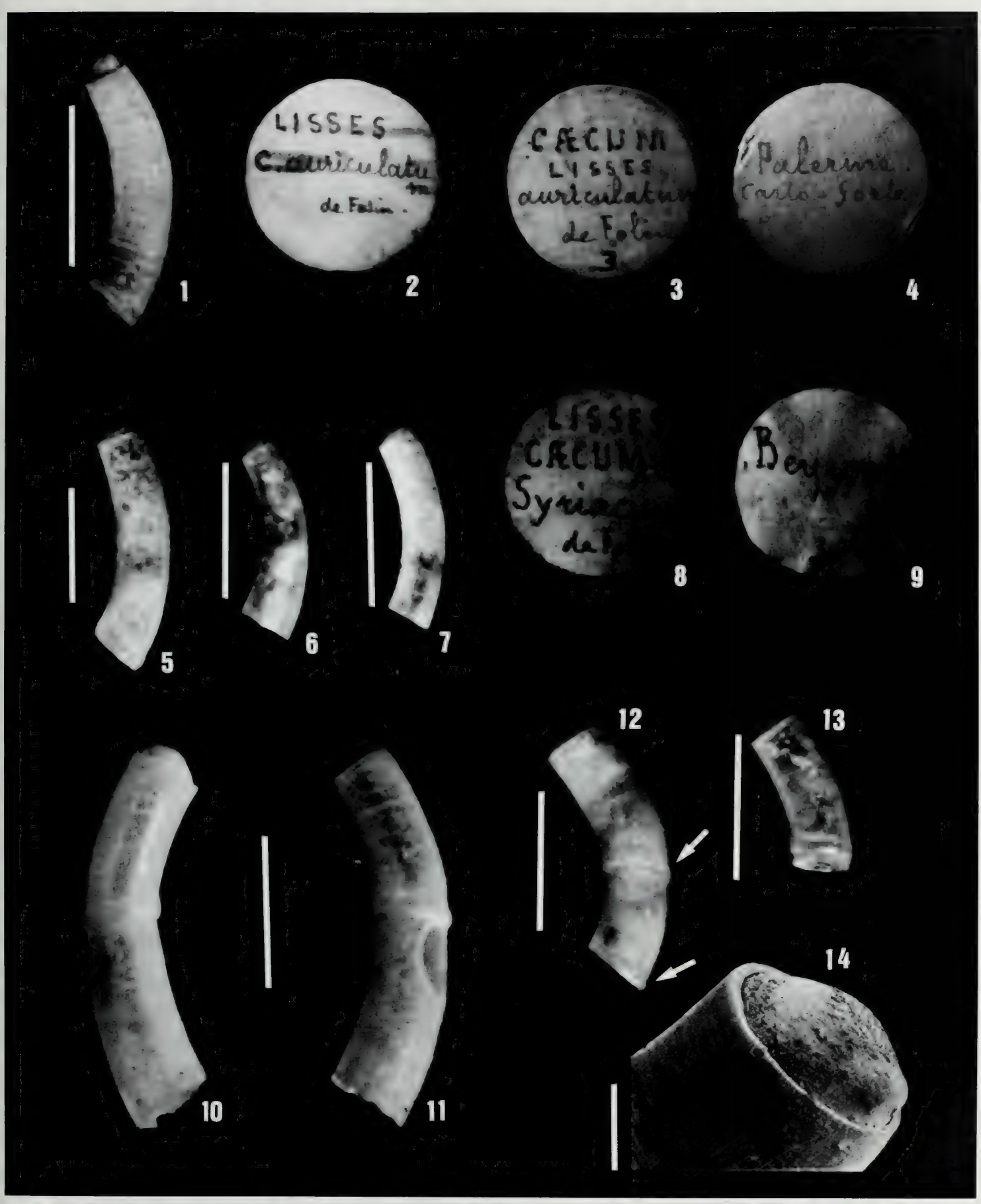
Figs. 1-14. (opposite page)

1. Holotype of *C. auriculatum* (MNHN, Paris), Palermo, Italy.
2-4. Labels accompanying the specimen of figure 1.
5. Porto Palo di Siracusa (Sicily, Italy), beached, VIII.1978.
6. Juvenile at the III stage, Salto di Fondi (Latina, Italy), beached.
7. Holotype of *C. syriacum* (MNHN, Paris).
8, 9. Labels accompanying the specimen of figure 7.
10, 11. Single-rimg form, Cala Calandra (Lampedusa Is., Italy), -30 m, 30.IV.1991.
12. Double-ring form, Civitavecchia (Rome, Italy), -3 m, sediment in a glass bottle.
13. Civitavecchia (Rome, Italy), -3 m, sediment in a glass bottle.
14. Septum of *C. auriculatum*, Pantelleria Is. (AG, Italy), -31 m.

Scale bars: 1 mm (1, 5-7, 10-13) and 200 µm (14).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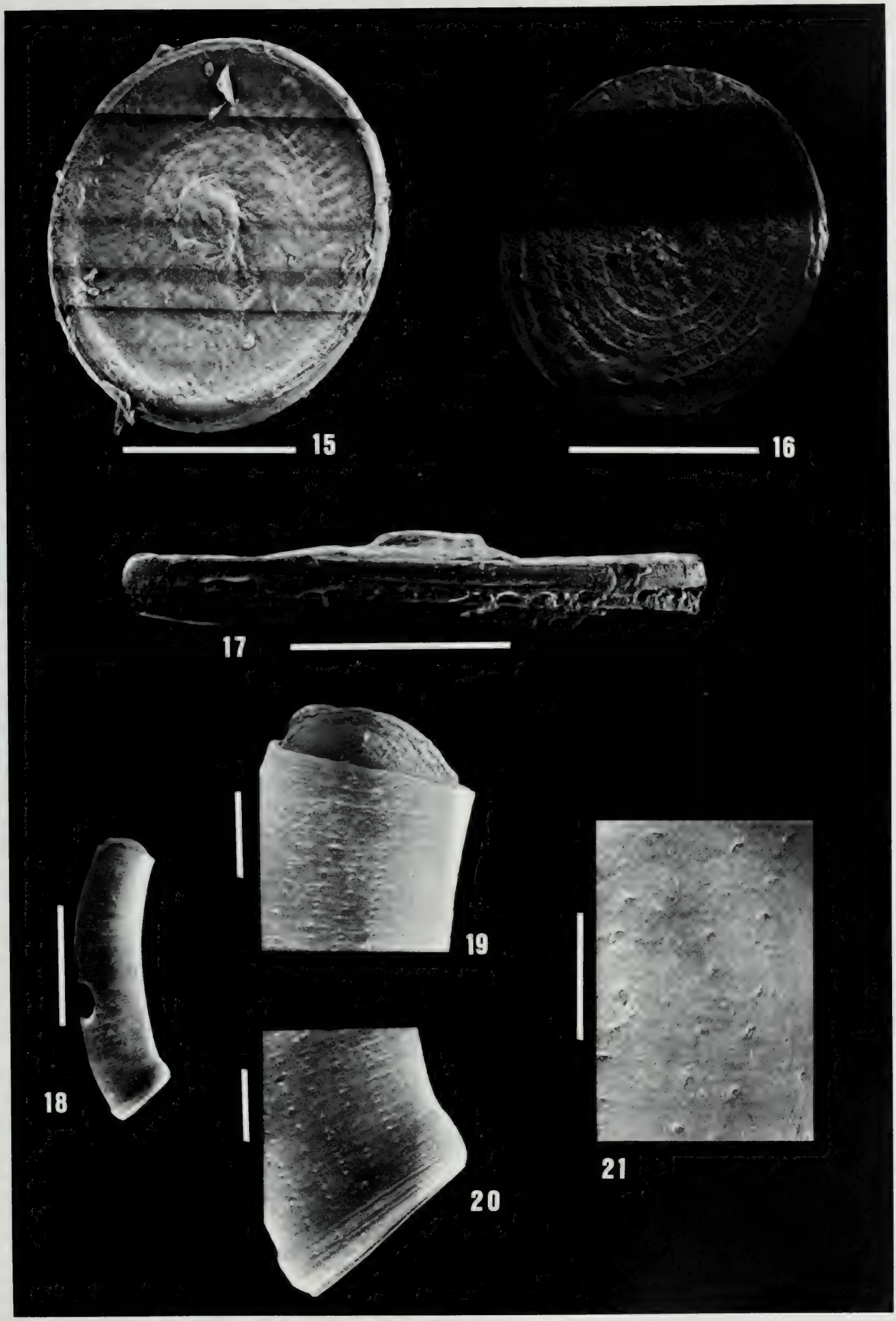
Figs. 15-21. (opposite page)

15-17. Operculum (15: inner side; 16: outer side; 17: lateral view) of *C. auriculatum*, Capo Palinuro (Italy).
18-21. *Caecum* sp. A (18: shell; 19: septum; 20: apertural ring; 21: particular of the pitted sculpture), Pantelleria Is. (AG, Italy), -31 m.

Scale bars: 200 µm (15-17, 19, 20), 50 µm (21), 1 mm (18).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Descriptions of two new species of *Caelatura* (Gastropoda, Rissoidea, Barleeidae) from Brazil.

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KEYWORDS: Gastropoda, Rissoidea, Barleeidae, Caelatura, Brazil.

ABSTRACT. *Caelatura spirocordata*, new species, is found from off the northern coast of Rio de Janeiro to off southern Bahia State, Brazil. The new species is diagnosed by 5 or 6 strong spiral cords on the body whorl which show almost linear rows of very small pits on their upper surfaces. *Caelatura barcellosi*, new species, is found in oceanic island and seamounts from Northeasthen Brazil. It is diagnosed by straight whorls, the presence of umbilicus, and 14-18 retractive axial ribs and sub and suprasutural cords forming blunt nodules at their intersections.

INTRODUCTION

Caelatura spirocordata new species, was collected on the northern continental shelf off Rio de Janeiro and off southern Espírito Santo State, during dredgings carried out by the oceanographic operation "Cabo Frio VII" (March to July 1983), as part of routine sampling by the Brazilian Navy to obtain basic oceanographic data on the coastal and oceanic regions off Brazil. Since 1966 malacological material from off the Brazilian coast has been obtained on a regular basis, by the botton sampling operations of the Brazilian Navy (Absalão, 1986, 1989). The malacofauna found during the Cabo Frio VII operation is characterized by numerous small mollusks; the minute specimens (< 5 mm) had received almost no attention.

Caelatura barcellosi new species, was obtained by oceanologist Lauro Barcellos during MORG expeditions to Atol das Rocas (1977 and 1982) and by the research vessel "N.Oc. ALMIRANTE SALDANHA" (Brazilian Navy) in 1989 from off Bahia State.

Abbreviations

AMS = Australian Museum (Sydney South), Australia.

ZMA = Zoological Museum, Amsterdam, The Netherlands.

IBUFRJ = Instituto de Biologia da Universidade Federal do Rio de Janeiro, Brazil.

MNHN =Museum National d'Histoire Naturelle (Paris), France.

MNRJ = Museu Nacional do Rio de Janeiro, State of Rio de Janeiro, Brazil.

MORG = Museu Oceanográfico da Fundação Universidade de Rio Grande, Brazil.

MZUSP = Museu de Zoologia da Universidade de São Paulo, State of São Paulo, Brazil.

USNM = National Museum of Natural History, Smithsonian Institution, USA.

BMNH =Natural History Museum (London), England.

SYSTEMATICS

FAMILY BARLEEIDAE Gray, 1857

GENUS *Caelatura* Conrad, 1865
Type species: *Pasithea sulcata* Lea, 1833

Caelatura spirocordata new species
Figures 1,2,3.

Microdryas sp.: Leal, 1989, p. 8, fig. 14.

Diagnosis: Teleoconch with strong spiral cords, 5 or 6 on the body whorl, upper surface with almost linear rows of small pits. Interspaces between cords with many irregular, wavy raised threads. Base with 4 spiral cords. Aperture with flaring outer lip.

Description: Shell minute. Length ranging from 0.95 to 1.93 mm and width from 0.67 to 0.97 mm. Shell golden brown immediately after death, light cream later on. Ovate, with rounded whorls. Suture impressed. Protoconch paucispiral with 2 1/2 whorls, first 1/2 whorl smooth, remainder with same ornamentation as teleoconch. Apical angle around 25°. Five or six spiral cords on body whorl. Spiral cords with approximately same width as spaces between. Top of cords show almost linear rows of small rounded pits, visible only under strong magnification. Interspaces between cords with many irregular wavy raised threads. Base rounded, with 4 spiral cords. Aperture moderately elongate-oval. Anterior part of outer lip flaring outward. No umbilicus.

Operculum and radula unknown.

Type locality: Off Atafona, northeastern Rio de Janeiro State, southeastern Brazil (21° 35'40" S, 40° 44'35" W), 16.8 m depth, Brazilian Naval Research Vessel "N. Oc. ALMIRANTE SALDANHA", CABO FRIO VII operation, station 51, 27 August 1979.

Type material: Holotype IBUFRJ 5948, length 1.71 mm, width 0.94 mm . Paratype 1, MORG 30591 off Rio de Janeiro State, Brazil, length 1.89 mm , width 0.85 mm. Paratype 6, IBUFRJ 5949, length 0.95 mm, width 0.67 mm. Paratype 7, MZUSP 27916, length 1.69 mm, width 0.83 mm. Paratype 9, MORG 30592, length 1.51 mm, width 0.85 mm. Paratype 2, MNRJ 6983, off northeastern Rio de Janeiro State, Brazil (21°31'35" S, 40°19'00" W), depth 41 m, Brazilian Naval Research Vessel ALMIRANTE SALDANHA, August 28, 1979. Paratype 3, USNM 860308, off Rio de Janeiro State, Brazil (21°26'50" S, 40°44'35" W), depth 40 m, August 29, 1979. Paratype 4, MNHN off Rio de Janeiro State, Brazil (21°16'50" S, 40°02'40" W), depth 35 m, August 29, 1979. Paratype 5, BM(NH) 1993134 off Rio de Janeiro State, Brazil (21°16'50" S, 40°02'40" W), depth 23 m, August 29, 1979. Paratype 8, ZMA 395016 (ex IBUFRJ 5950) off Rio de Janeiro State, Brazil (21°47'40" S, 40°16'00" W), depth 54.9 m, August 29, 1979, length 1.93 mm, width 0.97 mm. Paratype 10, AMS C201101, off Rio de Janeiro State, Brazil (21°40'30" S, 40°01'55" W), depth 41.1 m, August 28, 1979, length 1.60 mm, width 0.86 mm. Paratype 11, Luiz Trinchão col., from Ribeira beach, Salvador, Bahia State, Brazil (13°00'00" S, 38°40'30" W), depth 1 m, July 30, 1994, length 1.59 mm , width 0.85 mm.

Etymology: The specific epithet *spirocordata* refers to the strong spiral cords of the shell.

Range: Coastal records of *C. spirocordata* are know only in the region between northern Rio de Janeiro State and southern Bahia State, Brazil. LEAL (1989) figured this species from Abrolhos Archipelago, and Mr. Luiz Trinchão showed us three specimens from Salvador, collected in beach drift, thus extending its range to northeastern Brazil.

Discussion. At first glance *C. spirocordata* looks like a species of *Alvania sensu* COAN, 1964 and PONDER, 1985 but differs from it in having a flaring aperture, strong spiral cords, with no trace of any axial sculpture, and almost linear series of pits on the upper part of the spiral cords. The new species bears a superficial resemblance to anabathrids, which have also punctate sculpture on the spiral cords and on the cordlets of the protoconch. However, *C. spirocordata* does not have a straight inner lip and D-shaped aperture as does the genus *Microdryas*. The new species has an oval aperture. *Microdryas* has a "dome-shaped, paucispiral protoconch with spiral rows of minute punctures" (PONDER, 1983), while *C. spirocordata* although has also a paucispiral protoconch but with spiral cords over most of its surface. Only the upper part of the spiral cords shows lines of small pits, while in *Microdryas* the protoconch is entirely covered by lines of small pits. It is more likely that the new species belongs in the genus *Caelatura*, *sensu* PONDER (1983). The sculptural characters are compatible with those present in *Caelatura* and the protoconch in the new species is agreeable with those in that genus: "smooth or with spiral lines; microsculpture of very closely-packed, minute irregular pits" (PONDER, 1983). The only discrepancy is the microsculpture: in species of *Caelatura* previously described, it is irregular and equally spread over the entire shell surface, while in *C. spirocordata* it is almost linear and restricted to the upper part of the spiral cords. These shell diferences might suggest that our new taxon may not be congeneric with *Caelatura*. However, because of the diversity in shell characters present in many rissoidean genera (based on soft parts), we tentatively allocated the new species to *Caelatura*, pending the study of at least the radula and operculum.

There is only one other named species of *Caelatura* occurring off the Brazilian coast (RIOS, 1994) originally described as *Rissoa (Cingula) pernambucensis* Watson, 1886. This

species occurs in deeper waters (640 m depth) than *Caelatura spirocordata* (1.0-54.9 m depth). *Caelatura pernambucensis* is also conchologically distinct from *C. spirocordata*, having axial ribs with no trace of spiral cords, while *C. spirocordata* bears only strong spiral and no trace of axial sculpture.

LEAL (1993, p.317, pl.11, figs. c,d,e,f and n) shows three unnamed *Caelatura* species (one of them described below); two out three share with *C. spirocordata* similar spiral cords and absence of any kind of axial sculpture. Besides that, *Caelatura sp.1* (LEAL figs. c,d,e) shows the same pattern of punctae on the upper part of spiral cords, but differs from it by less convex outline, fewer spiral cords per whorl, and by more regular (almost straight), raised threads from the interspaces. *Caelatura sp.3* (LEAL fig. n, p) although with the same general outline, has whorls that are less convex than *C. spirocordata,* and differs markedly in protoconch morphology. The protoconch in *Caelatura sp.3* is covered by numerous spiral threads crossed by axial ridges forming a cancellated pattern with deep squarish pits; while *C. spirocordata* has no trace of neither axial threads nor cancellate sculpture. *Caelatura spirocordata* has teleoconch ornamentation extending over almost all protoconch.

Caelatura barcellosi new species, Figures 4,5,6,7.

LEAL, 1993, p. 317, pl.11, figs. i,j,k,l,m.

Diagnosis: Shell conic, whorls straight. Umbilicated. Protoconch paucispiral with apice hammered and remainder with 5 or 6 spiral cordlets. Teleoconch with 14-18 retractive axial ribs and sub- and suprasutural cords forming blunt nodules where they cross.

Description. Shell small, conic, white, whorls straight. Lenght ranging from 1.2 to 2.5 mm. Protoconch paucispiral, apex dome- shaped with hammered appearance, the remainder with 5 or 6 fine spiral cordlets. Suture impressed. Apical angle around 38°. Teleoconch with 14-18 retractive axial ribs extend over base fainting towards aperture. Sub- and suprasutural spiral cords present. Body whorl showing a third spiral cord on the lower third. Blunt nodules present where axial ribs and spiral cords crossed. Suprasutural nodules always larger than subsutural nodules. Teleoconch surface covered by microscopic spiral ridges of pits. Base convex, aperture oval, holostomate. Small umbilicus present.

Operculum oval, solid, inner side bordered by a ridge, a strong longitudinal rib present. A long peg raises from nucleus and extends beyond inner edge.

Radula unknowm.

Type locality: Off Bahia State, Northeastern Brazil, 50m depth, Brazilian Naval Research Vessel "N. Oc. ALMIRANTE SALDANHA", MONITOR VI operation.

Type material. Holotype MORG 30766, length 2.4 mm, width 1.3 mm. Paratype 3 USNM, length 2.3 mm, width 1.3 mm. Paratype 4 BM(NH), length 2.1 mm, width 1.2 mm. Paratype 5 ZMA 395015. Paratype 8 AMS, length 2.5 mm, width 1.3 mm. Paratype 9 IBUFRJ 6509, length 2.3 mm, width 1.3 mm. Paratype 1 IBUFRJ 6375 off Abrolhos, Bahia State, Brazil, Paulo Marcio col., 1990, length 1.6 mm, width 0.9 mm. Paratype 2 MZUSP 28108 Atol das Rocas, Bahia State, Brazil, 3 m depth, Lauro Barcellos col., February, 1982, length 1.7 mm, width 1.0 mm. Paratype 6 MNHN, length 1.7 mm, width 1.1 mm. Paratype 7 MNRJ 7159, length 1.6 mm, width 1.0 mm. Paratype 10 MORG 32882, length 1.7 mm, width 0.9 mm. Paratype 11 MORG 32883, length 1.7 mm, width 1.0 mm.

Etymology: This species is named in honour of Lauro Jesus Perello Barcellos who collected specimens of this species at Atol das Rocas.

Range: *Caelatura barcellosi* is known only from oceanic islands (Atol das Rocas and Abrolhos) from northeasthern Brazil and Vitoria and Dogaressa Seamount off easthern Brazil (see LEAL, 1993).

Discussion. *Caelatura barcellosi* conforms to the generic shell description, exception made to the presence of umbilicus; according to PONDER (1983, p.244), *Caelatura* is non-umbilicate. Our specimens are umbilicate (Fig. 4) but those figured by LEAL (1993, p.317, pl.11, figs.i,h,j) are not. So, we believe that the presence of umbilicus is a variable character among populations of *Caelatura barcellosi*. Our specimens are from Atol das Rocas and Abrolhos (umbilicate populations), while Leal figures shows specimens from Vitoria and Dogaressa Seamounts (non-umbilicate populations). None of our specimens were collected alive, and opercular characters are based on LEAL (1991) figures (p.317, pl.11, figs. f,g,h and k).

The nodulose sculpture and straight whorls of *Caelatura barcellosi* clearly separates it from *C. pernambucensis* and from *C. spirocordata*. The former lacks nodulose sculpture and has fewer axial ribs than *Caelatura barcellosi*. *C. spirocordata* lacks both axial sculpture and nodules.

Acknowledgments.

We are grateful to Biol. Paulino Soares de Souza Jr., who first suggested the specific name for *Caelatura spirocordata*, and to Dr. José H. Leal and Dr. Winston Ponder for their comments and corrections; especially to Dr. Leal who gently sent us a SEM photo of *Caelatura barcellosi* operculum. We are also much obliged to the Laboratório de Ultraestrutura Celular e Microscopia Eletrônica do Instituto de Biofísica Carlos Chagas Filho, of the Universidade Federal do Rio de Janeiro for the SEM pictures. This work was partially supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) fellowship n° 520297/94-6.

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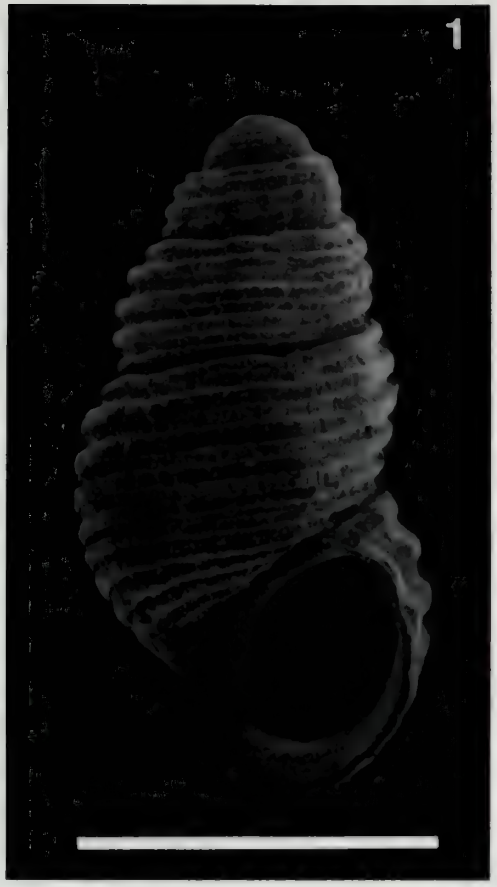
Figures 1-3 (opposite).
Caelatura spirocordata new species.
1- Holotype, IBUFRJ 5948, scale bar = 1.0 mm.
2- Details of ornamentation, scale bar = 0.01 mm.
3- Protoconch, scale bar = 0.1 mm.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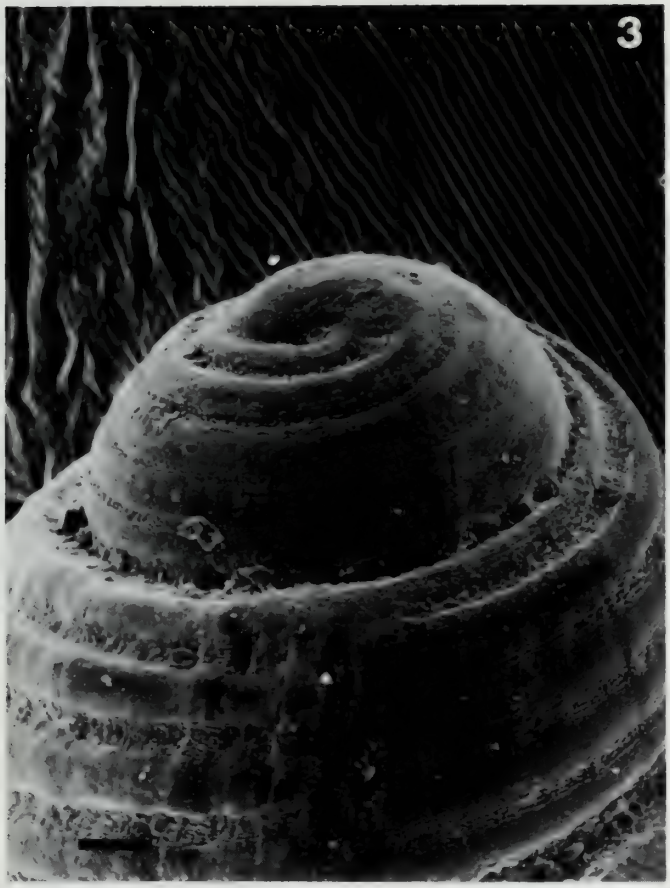
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Figures 4-7 (opposite).
Caelarura barcellosi new species.
4- Holotype, MORG 30766, scale bar = 0.5 mm.
5- Protoconch, scale bar = 0.05 mm.
6- Details of protoconch and teleoconch ornamentation, scale bar = 0.02 mm.
7- Operculum, scale bar = 0.1 mm.

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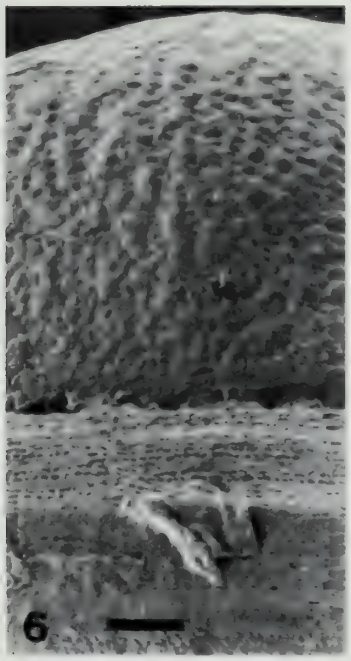
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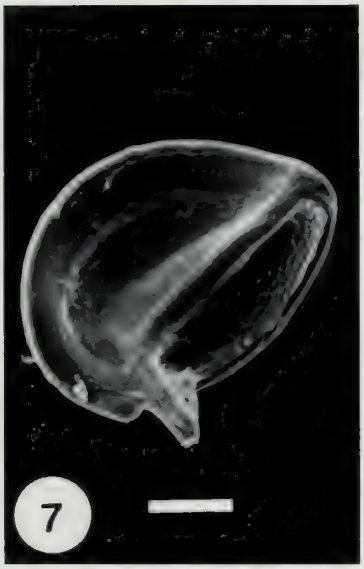
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Description of a new species of *Morum* from the Indian Ocean (Gastropoda: Harpidae)

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KEYWORDS: Gastropoda, Harpidae, *Morum*, new species, Indian Ocean.

ABSTRACT. *Morum* (*Oniscidia*) *vicdani* new species is described from 12-200 m off Saya de Malha Bank, Indian Ocean (*ca.* 10°30'S, 62°25'E) and compared with congeners.

INTRODUCTION

A number of new species and otherwise interesting discoveries of mollusks have been made in recent years by Russian and Japanese commercial fisheries operations and biological oceanographic surveys undertaken on or near Saya de Malha Bank (ca. 10°30'S, 62°25'E) in the western Indian Ocean (cf. BOUCHET and BAIL, 1991; OKUTANI, 1991; EMERSON and SAGE, 1991; BONDAREV and ROECKEL, 1992; BONDAREV, 1995; SIRENKO, 1995).

Through the good offices of Donald Dan, specimens of an unnamed species of *Morum* were submitted to the author for study. I take pleasure in describing this new species in honor of Victor Dan of Manila, Philippines, a connoisseur of Old World mollusks.

Abbreviations used for institutions:
AMNH = American Museum of Natural History, New York, USA;
BM(NH) = British Museum of Natural History [now The Natural History Museum], London, England.

SYSTEMATIC TREATMENT

Family **HARPIDAE** Brown, 1849
Subfamily **MORUMINAE**
Hughes & Emerson, 1987
Genus *Morum* Röding, 1798
Subgenus *Oniscidia* Mörch, 1852

Morum vicdani, new species
(Figs. 1-6)

Morum (*Oniscidia*) cf. *grande* (A. Adams, 1855), BONDAREV, 1995: 48, 49, fig. 3; [not *Morum grande* (A. Adams, 1855)].

Two specimens, one of which was illustrated in color, were reported "... to have been dredged from the [Saya de Malha] bank lagoon at about 80-100 m. depth by R/V IKHTIANDR in 1989."

Morum (*Cancellomorum*) sp. SIRENKO, 1995: 11, 16, fig. 14.

A specimen, illustrated in color, was reported from a depth of 12 m on the Saya de Malha Bank.

Diagnosis: Similar to *Morum* (*Oniscidia*) *grande* (A. Adams, 1855: 185), but *M. vicdani* n. sp. differs in having a more fusiform outline and a much less dense shell, with fewer axial ribs (10 to 12 *vs.* 17 to 19) and a thinner, less pustulated parietal shield, and with the exterior edge of the outer lip non-crenulate at maturity.

Material Examined: Holotype, (Figs. 3, 4), 59.5 mm in length, 36.2 mm in width (AMNH n° 226517); Paratype 1, (Figs. 5, 6), 57.0 mm in length, 33.1 mm in width (AMNH n° 226518); Paratype 2, (Figs. 1, 2), 47.1 mm in length, 28.0 mm in width (AMNH n° 226519). Only a very few other specimens of this taxon are known and these are in private collections (*teste* Donald Dan).

Type Locality: Trawled off Saya de Malha Bank, Indian Ocean in *ca.* 200 m, in 1986 (holotype).

Description: Spire raised, shell inflated, thin, elongately fusiform with cancellate sculpture. The 10 spiral ribs on the body whorl more prominent than the 10 to 12 axial ribs, forming blunt spines at the intersections and with fine axial threads crossing the interspaces and spiral ribs. Outer lip weakly reflexed, marginal edge smooth, not crenulate, with irregularly placed plications on the inner edge. Parietal callus thin with irregularly placed pustules on the marginally raised shield. Protoconch of 2 1/2 smooth whorls. The five postnuclear whorls cancellate. Base color white

Figures 1-6. (opposite) *Morum vicdani*, new species.
1, 2, Paratype 2, AMNH n° 226519.
3, 4, Holotype, AMNH n° 226517.
5, 6, Paratype 1, AMNH n° 226518.
All figures x1.

with 4 tanish brown, discontinuous spiral bands in the form of isolated, narrow, irregular, bar-like axial lines on the body whorl; aperture white. The spiral color bands are weakly defined in some specimens. No soft parts available for study.

Discussion: The new species and *Morum* (*Oniscidia*) *praeclarum* Melvill, 1919, from off Somalia, Mozambique and the Seychelle Islands, are the only species of *Morum* known to be living on the African lithospheric plate (cf. EMERSON, 1990: 152). *Morum grande*, in contrast, occurs from southern Japan to the Philippine Islands, Indonesia, and SE Australia on the Eurasian, Philippine and Indo-Australian plates, respectively. Two morphological forms of *M. grande* have been recognized: a stout obese shell is more commonly found in the northern part of the range (EMERSON 1985, pl. 2, figs. 1, 2) and a larger, more elongate shell is more frequently encountered in Australian waters (EMERSON, 1985, pl. 2, figs. 3, 4). The taxonomic significance of this shell dimorphism has yet to be determined. The new species more closely resembles in outline the southern form (WILSON et al., 1994: 139, pl. 30, figs. 1, 4). The northern form is represented by the lectotype of *M. grande* (YEN, 1942: 214, pl. 17, fig. 104) from the "China Seas." The lectotype is BM(NH) (n° 1966726) (DANCE and EMERSON 1967: 95) and measures 61.0 mm in length and 53.8 mm in width (EMERSON, 1985: 54). *Morum grande* has been confused with *M.* (*Oniscidia*) *cancellatum* (Sowerby, 1824: pl. 233, figs. 1-3; EMERSON, 1985: 52, pl. 1, figs. 17, 18 = lectotype, BM(NH) n° 197744), but differs in its larger size (attaining 75 mm in length), higher spire, more numerous axial ribs, more narrowly spaced spiral cords and a wider expansion of the outer lip. *Morum cancellatum* is distributed from southern Japan to the Philippine Islands, the East and South China Seas, and is also known from the Fiji Islands (EMERSON, 1990: 152). The type locality is the Straits of Formosa, off Taiwan (EMERSON, 1985: 54). With the description of *Morum vicdani* n. sp., 17 species of *Morum* (16 in *Oniscidia*, 1 in *Herculea* Hanley, 1858) are now recognized as living in the Indo-west Pacific biogeographic region (EMERSON, 1990: 150).

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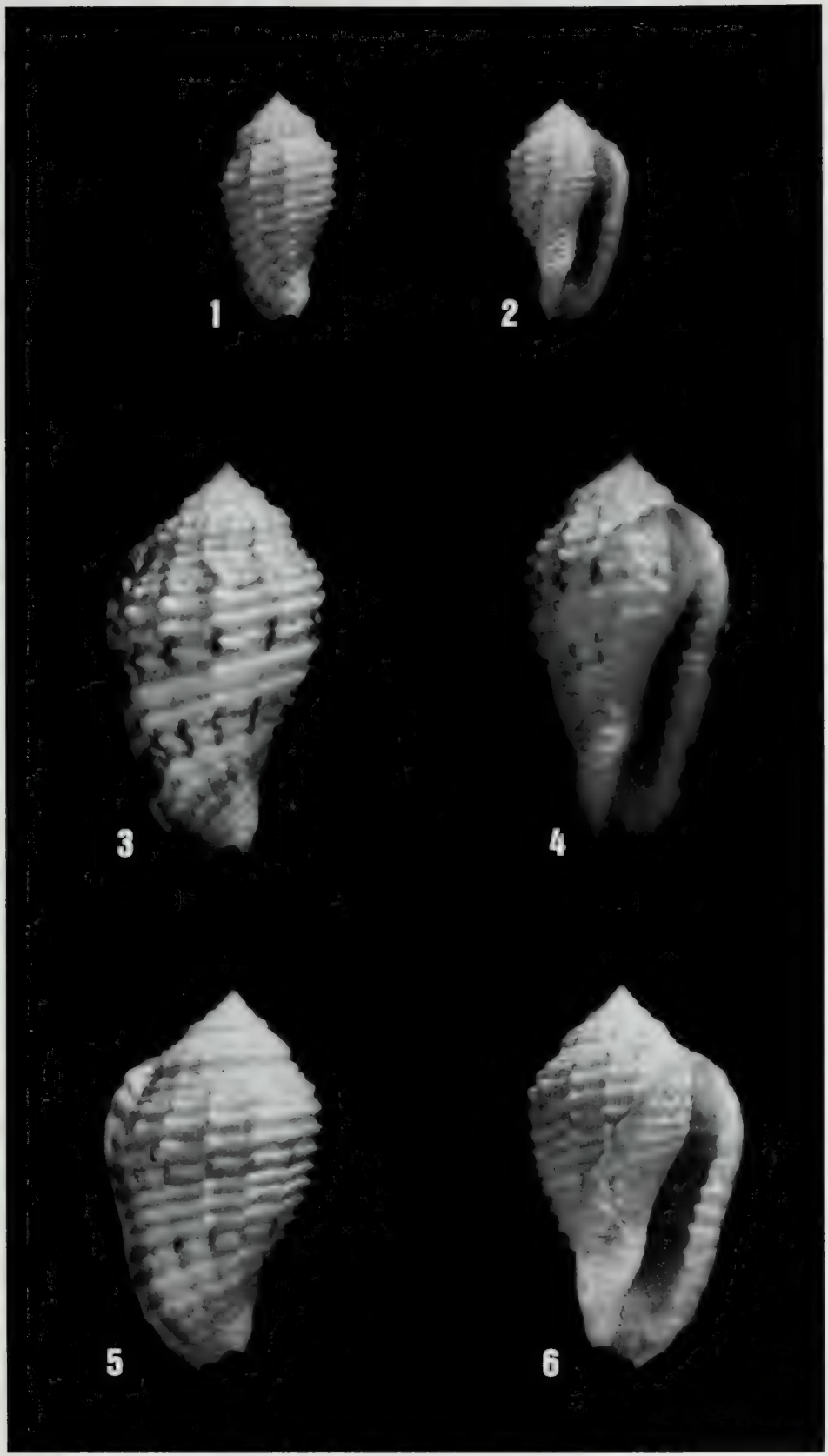
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Conus bahamensis n. sp., a name for an elusive cone

Danker L. N. VINK,
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and
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KEYWORDS: Gastropoda, Conidae, *Conus caribbaeus, Conus bahamensis*, new name, Bahamas

INTRODUCTION:

The identity of *Conus caribbaeus* Clench, 1942 is based on one specimen, the holotype, from off Palm Beach Co., Florida and two specimens, paratypes, from New Providence, Bahamas. Already WALLS [1979] considered *Conus caribbaeus* to be a synonym of *Conus flavescens* Sowerby, 1834 which he wrongly identified as *Conus magellanicus* Hwass in Bruguière, 1792, assuming the type of *Conus magellanicus* to be an unusual specimen. COOMANS et al. (1983) also came to the conclusion that *Conus caribbaeus* only represents a colour form of *Conus flavescens*. VINK (1987) supported these views and pictured the holotype of Conus *caribbaeus* together with another, also white specimen of *Conus flavescens*, showing their similarity.

Meanwhile, however, various collectors and dealers identify another species of *Conus*, subsequently discovered in the Bahamas, as *Conus caribbaeus* Clench, 1942. VINK (1987) pointed out that this identification is in error, and that probably a new, distinct species is involved.

We have tried to find more specimens of this elusive species and studied the extensive da Motta collection of Conidae now deposited in the Staatliches Museum für Naturkunde in Stuttgart, Germany. Three specimens of "*Conus caribbaeus*" from this collection are *Conus flavescens*, but one specimen of "*Conus caribbaeus*" does correspond to the new species. Da Motta obtained this specimen ex collection Bitler. With this specimen selected as the holotype we are now in a position to give the new species a proper name.

DESCRIPTION:

Conus bahamensis n. sp.
Figures 1, 2, 3

Conus caribbaeus Clench - KAICHER (1977): card n° 1041 (not *Conus caribbaeus* Clench, 1942).

Conus caribbaeus Clench - LOZET & PETRON (1977): n° 198, p. 108, 110, 111 (not *Conus caribbaeus* Clench, 1942).

Conus species n° 1 - VINK (1987): figs. 3c & 4b (paratype 2), 4a (paratype 1)

Type material

Holotype: Staatliches Museum für Naturkunde, Stuttgart, Germany, SMNS-ZI-8660, 31.1 x 16.8 mm. Dredged in 40 fms off Cat Cay, Bahamas.(Figures 1-3).

Paratype 1: 28.5 x 14.9 mm, from Bahamas, coll. Röckel. (Figure 4).

Paratype 2: 26.6 x 15.4 mm, from Cat Island, Bahamas, in coll. Vink.

Distribution

Only known from the Bahamas with record from Cat Island.

Description

Shell of moderate size (length 25-31 mm). Last whorl pyriform, relative diameter (maximum diameter/aperture height) 0.66-0.67. Spire of moderate height (relative spire height 0.19-0.21), slightly stepped; outline concave. Protoconch eroded. 8-9 teleoconch whorls. First 4-6 teleoconch whorls slightly tuberculate. Last teleoconch sutural ramps with one broad spiral groove and with fine axial striae. Last whorl smooth except for 8-10 spiral ribs near base. Aperture narrow. Colour yellowish-white, usually with a broad whitish band at centre of last whorl and near the shoulder.

DISCUSSION

Conus bahamensis n. sp. is similar to *Conus mindanus* Hwass in Bruguière, 1792, *Conus flavescens* Sowerby, 1834, and *Conus puncticulatus* Hwass in Bruguière, 1792. *Conus mindanus* (Figures 5, 6) can be distinguished by its conical last whorl, the straight outline of the spire, deep concave sutural ramps and the lack of tubercles on the teleoconch whorls. *Conus flavescens* (Figure 7) has a more narrow last whorl (relative diameter 0.58-0.61) with almost straight outline; its spire has a straight outline and concave sutural ramps. *Conus puncticulatus* (Figures 8, 9) is smaller (<25 mm) with a bluish violet ground colour (white in the population known as *Conus columba*) and often a brown pattern, it has an ovately shaped last whorl and a carinate shoulder; its anterior end is more distinctly twisted.

Acknowledgement. We are grateful to Dr. Niederhöfer of the Stuttgart museum for his assistance and the loan of specimen SMNS-ZI-8660, which now has been selected the holotype of *Conus bahamensis* n. sp.

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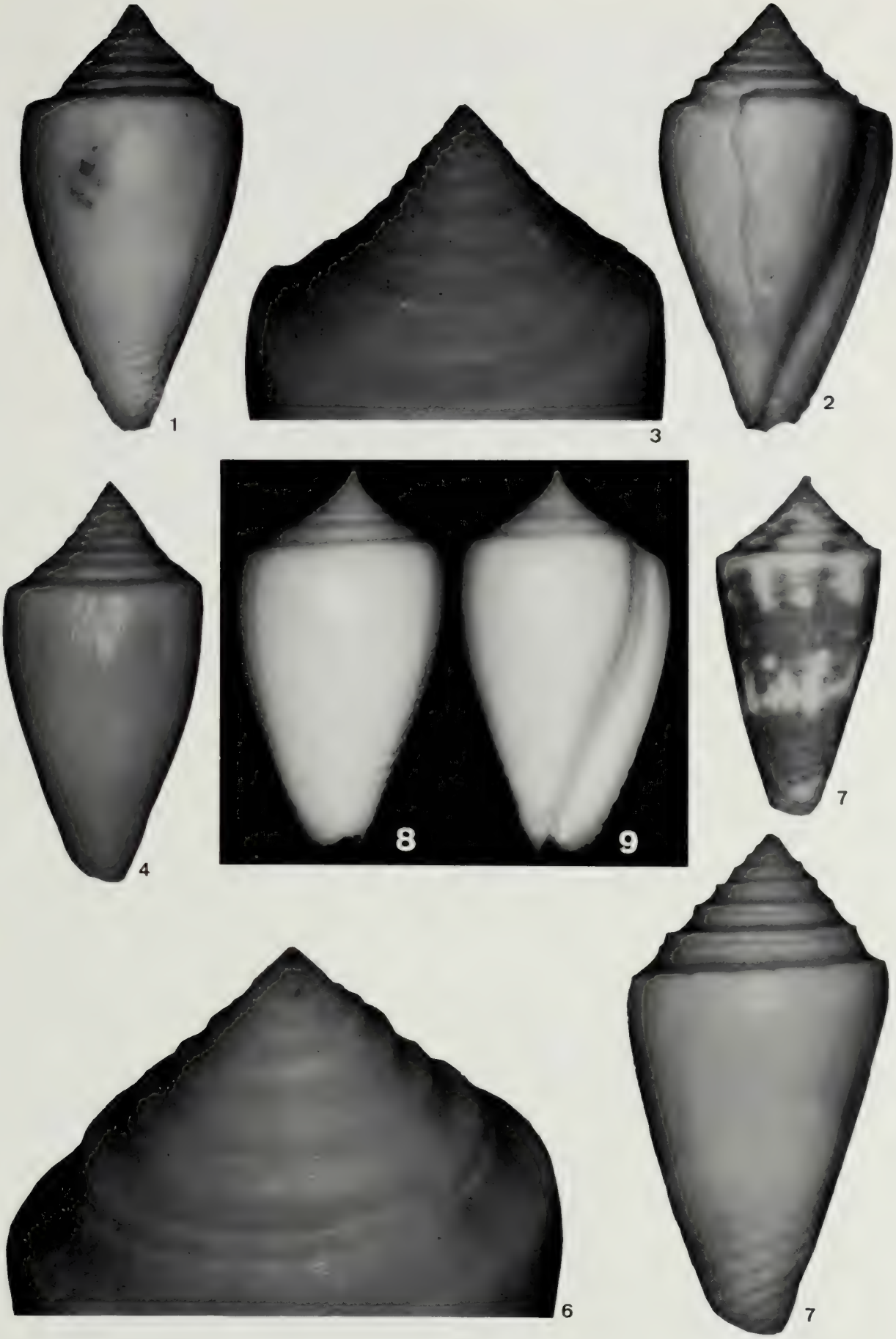
WALLS, J.G. [1979]. *Cone shells, a synopsis of the living Conidae*: 1-1021. Hong Kong.

Figures 1-9 (opposite page).

Figures 1, 2, 3: Holotype of *Conus bahamensis* n. sp. (dorsal side, ventral side, spire).
Figure 4: Paratype 1 of *Conus bahamensis* n. sp. (dorsal side).
Figures 5, 6: *Conus mindanus* Hwass in Bruguière. 1792 (dorsal side and spire). Coll. Röckel, 35.9 x 19.6 mm; Florida.
Figure 7: *Conus flavescens* Sowerby, 1834. Coll. Röckel, 23.8 x 12.0 mm; Bahamas.
Figures 8, 9: *Conus puncticulatus* Hwass in Bruguière, 1792 (dorsal and ventral side). Coll. Röckel, 23.4 x 13.1 mm; Guadeloupe.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Chronological analysis of the *Conus gradatus* complex (Gastropoda, Prosobranchia, Conidae), with the rediscovery of the holotype of *Conus scalaris* Valenciennes, 1832.

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KEY WORDS: Conidae. *Conus scalaris* Valenciennes, 1832, rediscovery of the holotype, identity. Provisional review of the "*Conus gradatus* complex".

ABSTRACT: the study of the "*Conus gradatus* complex" reveals that in literature a large confusion had been perpetuated from one author to the other since Sowerby II, 1857. The whole group is here re-examined in order to clear up the identity of *Conus scalaris* Valenciennes, of which the holotype was just retraced in M.N.H.N. A new description of this species is given. Lectotypes are designated for *C. gradatus thaanumi* and *C. recurvus helenae*.

RÉSUMÉ: l'étude du "Complexe de *Conus gradatus*" révèle qu'il existe, dans la littérature consacrée à ce groupe, une grande confusion qui a été répercutée d'un auteur à l'autre depuis Sowerby II, 1857. L'ensemble du groupe est révisé afin de dégager l'identité de *Conus scalaris* Valenciennes, dont l'holotype vient d'être retrouvé au M.N.H.N. Une nouvelle description de cette espèce est donnée. Des lectotypes pour *C. gradatus thaanumi* et de *C. recurvus helenae* sont désignés.

INTRODUCTION

Conus scalaris Valenciennes belongs to a group of Conidae, generally classified in the subgenus *Leptoconus* Swainson, 1840. The distribution range of this group stretches along the American west coasts, from the extreme North of the Gulf of California to the Ecuador. This group may be called the "*Conus gradatus* complex", from the oldest and first available name in this group.

This "complex" has been often erroneously treated in literature. An utter confusion prevails in its taxonomy, partly due to former misidentifications which were perpetuated for nearly one and a half century by successive authors, partly due to the morphological resemblances between different species, and to a remarkable variability in the populations from one area to the other.

Another reason of this taxonomical confusion can be found in the fact that for 14 taxa described during the 19th. century, only 4 have been based on a type-shell, 9 remaining ones are identifiable only by more or less precise type-figures, one other has no available type or type-figure. For this study, following taxa (in chronological order) will be analysed:

	TYPES	TYPE-LOCALITIES
14 taxa described before 1900		
C. gradatus Mawe, 1823	none	"California"
C. gradatus Wood, 1828	lectotype figure	"San Pedro Isl., Sonora, Mexico"
C. scalaris Valenciennes, 1832	lectotype figure	"Acapulco"
C. regularis Sowerby, 1833 (17 May)	lectotype figure	none
C. monilifer Sowerby, 1833 (24 May)	lectotype	"Salango, Ecuador"
C. recurvus Broderip, 1833 (24 May)	lectotype	"Monte Christi"
C. incurvus Sowerby, 1833 (June or July)	lectotype figure	"Monte Christe"
C. syriacus Sowerby 1833 (post July)	lectotype figure	none
C. dispar Sowerby, 1833 (post July)	lectotype figure	none
C. arcuatus Gray, 1839 (1)	lectotype figure	"Pacific Ocean"
C. gradatus Reeve, 1843 (2)	lectotype	"Salango"
C. emarginatus Reeve, 1844	lectotype figure	"Near Mazatlan, Mexico"
C. candidus Kiener, 1845 (3)	lectotype figure	none
C. angulatus A.Adams, 1853	lectotype	none
6 taxa described after 1900:		
C. scariphus Dall, 1910	holotype	"Isl.del Coco, Costa Rica"
C. magdalenensis Bartsch & Rehder, 1939	holotype	"Bahia de Magdalena, Baja California"
C. gradatus thaanumi Schwengel, 1955	lectotype	"Bahia Salinas, Costa Rica"
C. recurvus helenae Schwengel, 1955	lectotype	"Curu,Gulf of Nicoya,Costa Rica"
C. poormani Berry, 1968	holotype	"Morro Colorado, Sonora, Mexico"
C. scalarissimus Da Motta, 1988	holotype	"Salango"

Nota:
1) - *C. arcuatus* Gray, 1839, being a junior homonym of *C. arcuatus* Broderip & Sowerby, 1829, has been rediscribed as *C. emarginatus* Reeve, 1844.
2) - *C. gradatus* Reeve, 1843, being a junior homonym of *C. gradatus* Mawe 1823 and *C. gradatus* Wood, 1828, has been replaced by *C. scalarissimus* Da Motta, 1988, *nomen novum*.
3)- The true identity of *C. candidus* Kiener, 1845 today remains uncertain (see below).

I
C .scalaris Valenciennes
(in Humboldt et Bonpland, 1832, 2: 338)

Achille Valenciennes (1794-1865) was a French zoologist and full professor at the Museum d'Histoire Naturelle in Paris (Chair of molluscs, zoophytes and worms). He translated Humboldt's "Zoologische Beobachtungen", published the "Histoire Naturelle des poissons"(1829-1849), of which the first 8 volumes where elaborated in collaboration with Cuvier, the "Histoire naturelle des mollusques, des annelides et des zoophytes" (1833), etc. .. In 1831, he was put in charge of publishing the description of the new species collected during the travel of Alexander von Humboldt and Aimé Bonpland through the equatorial America 1799-1803 ("Je dois à l'amitié dont m'honore depuis si long-temps M.de Humboldt, d'avoir été chargé du soin de ces publications." (Valenciennes in Humboldt & Bonpland, 2: 262.)

1) Original diagnosis:

"Conus scalaris, *testa oblonga, fusiformi, subtiliter costigera, albida, rufo longitudinaliter variegata, anfractibus ad basim angulatis et in spiram scalarim decurrentibus, spira conica acuta.* (Conus scalaris, elongated shell, fusiform, finely striated, whitish, longitudinally mixed with reddish-brown, with coils angulated towards their base, extending along the spire like ladder steps, spire conical and pointed.)

Habitat ad portum Acapulco."

2) Original description (tranlated from French):

" This nice shell is composed of nine distinct separated whorls, less closely coiled than those of other Cones. Near the base of each whorl there exists a sharp carina which forms a flat spiral ramp along the spire. The height of the basal cone (1) represents almost the half of the shell's height. The axial striae are not very distinct; but the spiral ones are separated and accentuated with well marked granules. The

basal ridges, towards the siphonal canal are only weakly visible.

The shell shows, on a white background, some large, more or less regular, yellow dashes. Some of them form flames which are not distinctly drawn. On the spire, the dashes are more reddish brown and generally more regular.

The shell measures only 11 lines in height (= 24.8 mm).

If we compare this species with the "Lost Cone" (*Conus deperditus*), a fossil which is common in the deposits of Grignon, Courtagon and Bordeaux, we can see that it differs from it only by a lower height of the basal cone (1), by the lack of transverse ribs, by numerous oblique well-marked folds above the serration, and by a more oblique and less broad spiral ramp.

These differences are sufficient to establish specific characters between both Cones; however the affinity between both species remains very stricking."

(1) Valenciennes uses the term "cône de la base", which may be interpreted as designating the body whorl of the shell.

3) *Conus scalaris* Valenciennes in literature:

The shell material Humboldt and Bonpland had collected during their voyage has been stored in the Museum d'Histoire Naturelle in Paris, where it has been, according to Valenciennes' statement (p. 262), passed on Lamarck. But strangely, after Valenciennes' description of *C. scalaris*, this name seems to have been unknown by the eminent conchologists of the Museum, except by Kiener.

KIENER (1845: 158) was the first to mention *C. scalaris*, and he wrote out Valenciennes' Latin diagnosis, with only a few changes of punctuation or accents. He gave a new description:

"Shell elongate, fusiform, with a very acute spire, composed of nine narrow whorls, carinate at their base with a flat spiral ramp. The body whorl is slightly ventricose towards its upper part. The entire surface of the shell is covered with weakly distinct axial striae and with granulated, narrow, equidistant spiral ones. The aperture is very narrow; its right border is fine and arched. The shell, with a white background, is stained with large, yellowish, more or less irregular dashes; some of them form longitudinal flammules. On the spire, the dashes are deeper coloured and more regular.

Long. 28 mm. - Lives in Pacific Sea, on the coasts of Acapulco."

Kiener adds: "This species, described for the first time by M. Valenciennes ... has strong analogy with *Conus acutangulus*; however it is distinct by its narrower and more slender form."

Kiener indicated that the shell was in "Collect. du Mus." (p. 158). He also was the first to illustrate *C. scalaris,* pl. 88, Fig. 5 (FIG. 7). There is no doubt that the figured shell was the specimen Valenciennes had described. The size difference between Valenciennes' statement (11 lines ~ 25 mm) and Kiener's one (28 mm) may be explained by Kiener's habit to "restore" and "beautify" somewhat damaged shells.

Neither REEVE (1843), SOWERBY I (1833-1839) nor LAMARCK (1845) mentioned *C. scalaris*. However in 1849 (p. 6) REEVE compared it with *C. acutangulus*, following Kiener's comment: "This species I have not seen, but the figure is so like the fusiform variety of *C. acutangulus* that I cannot forbear suggesting the comparison". SOWERBY II (1857: 14, n° 106, Pl. 9, fig. 192) misidentified *C. scalaris* and considered it as a junior synonym of *C. gradatus* Reeve (FIGS. 1 & 2). Thus it can be considered that Sowerby II was at the origin of the concept of what may be called "*C. scalaris* auctorum" (not Valenciennes), concept which was reflected by the large majority of following authors, such as TRYON (1884: 122) who differentiated *C .scalaris* ValenC. from "*C. ocalaris*" (a misprint for *scalaris* (p. 136)) "Valenciennes in Kiener, pl. 88, fig. 5" (FIG. 3), which he considered as a synonym of *C. arcuatus* Broderip & Sowerby, 1829.

In more recent literature, DALL (1910: 221) only mentioned the name, ranking *C. scalaris* among the forms which may be regarded as "species or varieties" of "*C. gradatus* Mawe". The author did not provide any illustration, so that no conclusion may be deduced about the identity of the concerned species. KEEN (1958: 486) misinterpreted *C. scalaris* and figured a shell (p. 487, fig. 942) which belongs to another, seemingly until today undescribed species, which subsequently I shall call *C. species* n°1. Also HANNA (1963, pl. 3, fig. 11; pl. 4, figs .1 & 3 (FIG. 4); pl. 7, fig. 3) figured the same species with the erroneous name *C. scalaris*, as well as MARSH & RIPPINGALE (1974, pl. XXIII, fig. 20) (FIG. 5), KAICHER (1977, part II, card n°1119) (FIG. 6), WALLS (1979: 527, 530-531, 534; figs. p. 340 below left, p. 344 all), and LAUER & RICHARD (1989: 18).

The specimen illustrated by EMERSON & OLD (1962: 23-24, fig. 12) is here attributed to *C. incurvus* Sowerby, but they figured a specimen of 38 mm, with the name "*C. regularis* form *monilifer*", on p. 21, fig. 8, which is here assigned to *C. scalaris*. This print

probably is the single figure of *C. scalaris* in literature after Kiener's and Tryon's ones.

DA MOTTA (1989), in his "Review of the *Conus regularis* complex" noted that "Kiener's figure (FIG. 7) (is) the most probable representation of Valenciennes' controversial *C. scalaris*", and concluded: "it remains an indeterminate species" which therefore should be regarded as a *nomen dubium*.

KOHN (1992: 237) concluded: "The original specimen is not preserved in the MNHN. It is very likely, however, to be the specimen figured by Kiener. The figure (KIENER, 1845: pl. 88, fig. 5) is here designated as representation of the lectotype of *C. scalaris* Valenciennes." He considered *C. scalaris* as "a valid species occuring on the Pacific Coast of Mexico".

4) Holotype of *C. scalaris* Valenciennes (FIGS. 8).

Although Kohn designated the figure in Kiener as "representation of the lectotype", Valenciennes did not mention another specimen he had examined, described or measured. Thus we must conclude that the description was based on a single individual, and this "lectotype" must be regarded as the holotype-figure.

This holotype was considered lost by all the recent authors. In the collections of the M.N.H.N. in Paris, a lot of 6 *Conus* specimens are preserved with the label of "*C. scalaris*" Valenciennes. However five of them are here attributed to other species of this group. The sixth one has been labelled "*C. fusiformis*" Lamarck, with an aberrant locality: "Océanie", and perhaps therefore somewhat disregarded. Dr.Georges RICHARD, in the course of a recent revision of the Conidae in M.N.H.N., re-labelled it as *C. scalaris* Valenciennes. During my first revisionary researches on the "*C. gradatus* complex", this specimen did not peculiarly draw my attention, but at my last stay in the Museum, I borrowed this specimen for examination. After a slight cleaning of the shell, and an examination under binocular microscope, it became obvious that this specimen was the one described by Valenciennes and figured by Kiener. All the details: number, forms, colours and locations of the dashes are strictly the same as in the type-figure. The holotype of *C. scalaris* Valenciennes was retraced.

Actual condition (FIGS. 8, 12):

Measurements: Shell height: 23.5 mm. Largest diameter: 9.6 mm. height of the body whorl: 15.8 mm. height of the spire: 7.7 mm. Weight: 1.18 gr.

Figures 1 to 11 (opposite page)

1 - "*C. scalaris*" (= *C. scalarissimus* da Motta, 1988) in Sowerby II, 1857, pl.9, fig.192) (x 1.4).
2 - *C. gradatus* Reeve (= *C. scalarissimus* da Motta), type-figure in Reeve, 1843, pl. 25, fig.140 (x 1).
3 - *C. scalaris* Valenciennes in Tryon, pl.27, fig.10 (x 1.4).
4 - "*C. scalaris*" (= *C. species* n°1) in Hanna, 1963, pl.4, figs 1 & 3 (x 1.2).
5 - "*C. scalaris*" (= *C. species* n°1) in Marsh & Rippingale, 1974, pl.XXIII, fig.20 (x 1.2).
6 - "*C. scalaris*" (= *C. species* n°1) in Kaicher, 1977, Card 1119 (x 0.8). Right: detail of the spire sculpture.
7 - *C. scalaris* Valenciennes, type-figure in Kiener, 1845, pl.88, fig.5 (x 1.4)
8 - *C. scalaris* Valenciennes, holotype, MNHN, Paris, 23.5 mm.
9-11 - *C. scalaris* Valenciennes, Bahia de los Angeles, Ballenas Channel, North-West of the Cortez Sea, Baja California. - **Fig.9**: dorsal and apertural view of a 43.7 mm specimen. - **Fig.10**: 49.4 mm. - **Fig.11**: 45.6 mm (Coll. Lauer).

Although the height given by Valenciennes is "11 lignes" (= 24.6 mm), the French line (= 2.26 mm) was the smallest length unit used at his time. Thus the actual length of the shell agrees with Valenciennes' original statement (11 lines = 23.5 - 25.7 mm)

Shell condition: protoconch eroded. Number of teleoconch whorls: 9. Basal border somewhat chipped and eroded. Outer lip broken in a length of about 11 mm. A deep growth-reformation scar runs along the height on the ventral side towards the columella. The colours are very faded.

Observations: the shell was obviously dead and bleached when taken, which is confirmed by sandy gravel still wedged in the aperture. The erosion of the protoconch and partly of the base seems to be the original condition of the shell. The break of the lip is certainly more recent, since Kiener noted that the aperture "right border is fine and arched".

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Additional description of the holotype:

The turreted spire shows strongly stepped teleoconch whorls, showing an oblique, slightly concave upper ramp and an inwards slanting lateral riser. The riser of the 5.5 earlier whorls is sculpted with solid oblique axial striations on its entire height, which give a slightly granulose aspect to the external whorl border (FIG. 12). This sculpture dwindles and disappears after 5 to 6 volutions. The following whorls are nearly smooth, showing only slight radial curved striae. Suture well marked. The body whorl is almost smooth and bears obsolete prominent, spiral somewhat granulated cords with nearly 1 mm wide flat spaces. Near the base, a series of 11 to 12 flat ribs separated by narrow sulci are observed. The earlier whorls are slightly tawnish coloured, the aperture is white inside.

The holotype of *C. scalaris* almost certainly is a juvenile shell, which explains the high value of the body whorl-Height/Spire-Height ratio (this ratio typically decreases with the growth of the shell). The colour pattern is incompletely formed and, as such, is hard to compare with other known species. Therefore it appears advisable to provide a description of adult shells:

5) Description of *Conus scalaris* Valenciennes (FIGS. 9-11):

Shell of medium size (38 to 55 mm) with a heightened, turreted and strongly stepped spire. Body whorl smooth, relatively glossy, showing fine and weak longitudinal, axially curved growth striae and 10 to 12 narrow, obsolete spiral ribs towards the base.

The protoconch is seldom intact. From the whole examined material is deduced an intermediate multispiral protoconch of 2.4 to 2.7, whitish to very pale chestnut larval whorls, followed by 5 early (postlarval) more deeply coloured teleoconch whorls. There are 10 strongly stepped teleoconch whorls, with a steep and slightly concave to nearly flat upper ramp, sculptured with narrow, close, fine and leftward strongly arched radial striae. No spiral sculpture is visible. Their external border is formed of an obtuse angle. The lateral riser, of which the oblique axial striations observed in the holotype (FIG. 12) are eroded and hardly visible, reaches nearly half the height of a whorl, and slopes inwards at its base. The general spire outline is slightly concave to nearly straight.

The shoulder, like the spire whorls, shows an obtuse angle with a slightly raised border.

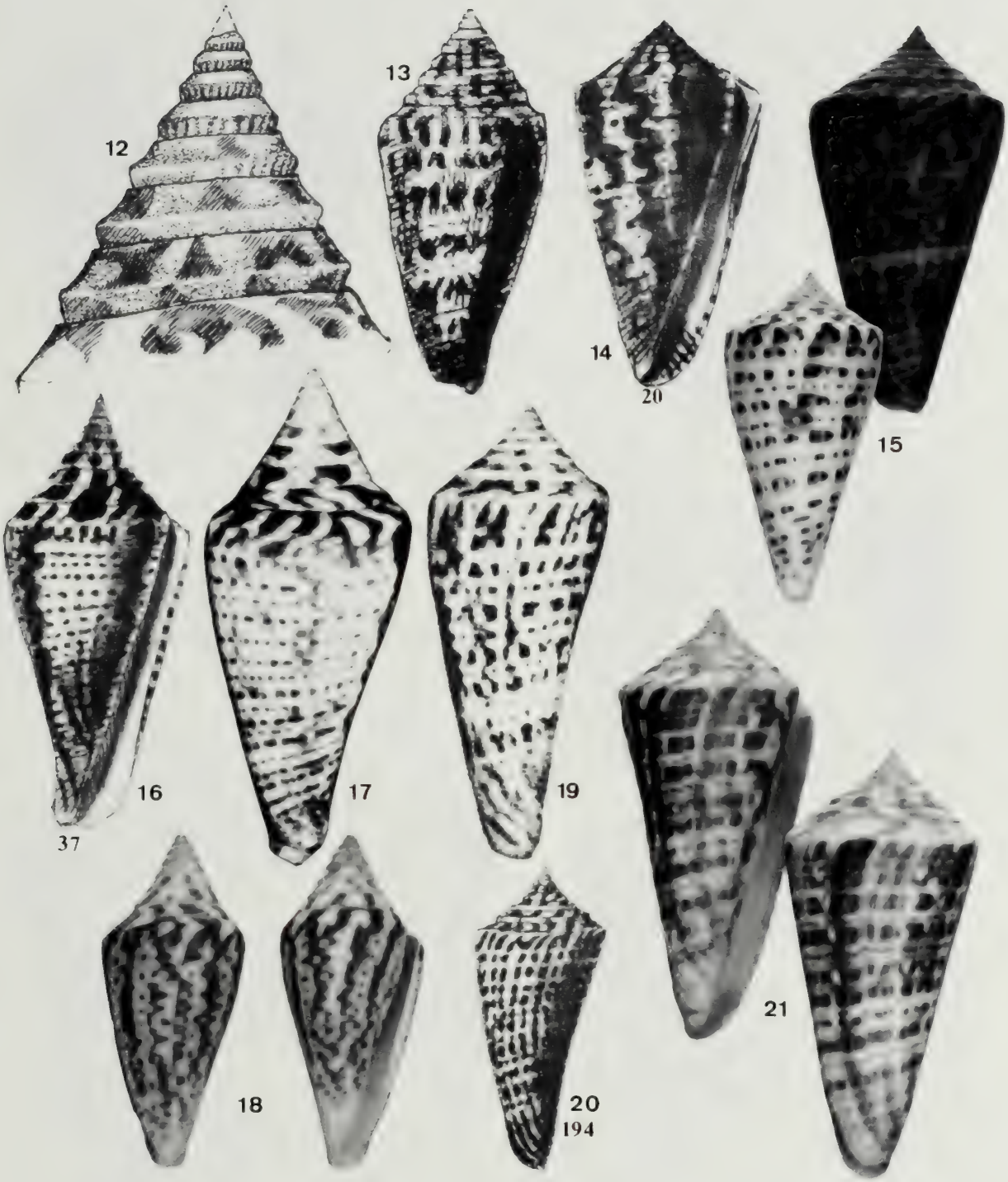
The body whorl has a fusiform profile, with slightly convex to nearly straight sides. The aperture is narrow, scarcely enlarging towards the base. The outer lip, fine and sharp, shows, along its internal narrow whitish border, the outer dotted colour pattern by translucence. Then, the aperture shows a more or less deep chestnut to lilac-chestnut lunula which lightens towards the inside. The columellar fold, fine and hardly visible is relatively rectilinear and is tinged with pinkish chestnut.

All teleoconch whorls, except the 2 or 3 earlier (postlarval) ones, are stained with reddish chocolate-brown dashes in form of leftward arched commas. The body whorl has a grayish to slightly bluish-white background which is covered with 5 to 7, more or less zigzaging, chocolate-brown axial flames. This pattern is overlaid with a series of 10 to 12 spiral alignments of more or less squarish deeper brown dots, alternated with alignements of smaller dark spots.

Periostracum, living animal, operculum, radulas and egg capsules remain unknown to me.

Figures 12 to 21 (opposite page)

12 - *C. scalaris* Valenciennes: earlier spire-whorls.
13 - *C. gradatus* Wood: lectotype-figure in Wood, pl.3 fig.6*b*, 17 mm (x 3.6).
14 - *C. regularis*: lectotype-figure in Sowerby I, 1833: pl.29, fig.29 (x 1.4)
15 - *C. regularis*: - left: light colour pattern, 45.6 mm, Bahia Conception, Mexico (Coll. Lauer)- right: dark colour pattern, 53.5 mm, "Asia" (Coll. Ballot, MNHN, Paris).
16 - *C. monilifer*: type figure in Broderip, 1833, part.29, fig.37 (x 1.4).
17 - *C. monilifer*: lectotype, "Salango", 50 mm, BM(NH), London.
18 - *C. monilifer*: "Montezuma" ?, 39.9 mm (Coll. Staadt, MNHN, Paris).
19 - *C. recurvus*: lectotype, "Monte Christi", 53 x 23 mm, BM(NH), London.
20 - "*C. incurvus*" (= *C. recurvus*) in Sowerby II, pl.9, fig.194 (x 1.4).
21 - *C. recurvus*, (Colombia ?) 59.9 mm (Coll.Lauer).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Distribution range: *C. scalaris* seems to be a rare species and thus its distribution range is poorly known. Only 5 specimens are known to me:

-the holotype: "Acapulco",

-one specimen figured - EMERSON & OLD, 1962 : 21 fig.8: 38 mm) from "San Marcos Island, Baja California (Sur - off Bahia Magdalena), Mexico, Station 149, shore collecting" stored in AMNH, n°76716,

-three adult specimens (43.7, 45.6, and 49.4 mm) in the author's collection , from Bahia de Los Angeles, Ballenas Channel, North-West of the Cortez Sea, Gulf of California, Baja California Norte, at about 3 m depth on shingle and scree bottom.

II
Provisional review of the taxonomic environment of *C. scalaris*.

To disentangle definitely the identity of *C. scalaris* as a separate valid species, it appeared advisable to revise, even if shortly, and on the basis of the available material, the whole *C. gradatus* complex:

A valuable revisionary work of this group should be based on a large lot of adequate shell material in good condition. Such material is nearly impossible to obtain for the moment. The type-material consists partly in type- figures which are hard to interpret, partly of type-shells in bad condition with broken or strongly eroded protoconchs. Thus the structure and the number of the larval whorls cannot be determined in a large majority of cases, and the number of teleoconch whorls is difficult to count. For this reason, I refer below to the "visible" whorls, which does not predjuge if they include one or more eroded larval whorls.

NYBAKKEN (1970) analysed the radula of all these species, but unfortunately he did not redefine or illustrate them. He only noted (p. 1) that he adopted the identifications given by KEEN (1958) and by HANNA (1963), whose opinions nevertheless diverged for several species. This way, only a small number of the examined radulas may be assigned with some certainty to well identified species. Thus, in the absence of more precise or adequate investigation methods (protoconchs, colour of living animals, egg capsules, radulas etc.) the following revision is essentially based on the general outline and structure of the shells, and on the number, profile, structure and sculpture of the remaining spire whorls. The colour patterns being very close from one species to another, these characters are here considered most often as secondary. For all these reasons the following review should be considered as only provisional, to be reconsidered only when more substantial material is available.

1) ***Conus gradatus*** Mawe, 1823: 90:

The name *C. gradatus* has been attributed to Mawe successively by DALL (1910), HANNA & STRONG (1949), HANNA (1963), NYBBAKEN (1970, 1971), and RICHARD (1990). However most authors attributed it to Wood, 1828.

A careful examination of the original material "The Linnean system of conchology" reveals that Mawe nowhere gave a description, an indication (in the sense of the "Code"), or a reference which allow to identify what species he intended to denote with the name *C. gradatus*. The single information he provided is: "*C. gradatus --- California --- Stepped Cone" (p. 90) among 36 Conus taxa he listed as "Elongated and rounded at the base". No figure is provided, no type shell is available. Thus *C. gradatus* Mawe must be considered a *nomen nudum*. ("Code", Art. 12). The same conclusion already has been suggested by EMERSON and OLD (1962: 20) and by KEEN (1971: 665).

Figures 22 to 31 (opposite page)

22 - *C. incurvus*, lectotype-figure in Sowerby, part 33, fig.36 (x 1.4).
23 - *C. incurvus*, "Guanacoste"(?), 48.8 mm (Coll.Staadt, MNHN, Paris).
24 - *C. incurvus*, San Felipe (Mexico), 47 mm (Coll. Estival, MNHN, Paris).
25 - *C. syriacus* (= *C. regularis*), lectotype-figure in Sowerby, 1833, part 36, fig.45 (x 1.4).
26 - *C. dispar*, lectotype-figure in Sowerby, 1933, part 37, fig.57 (x 1.4).
27 - *C. dispar* in Kaicher, 1977, Card 1126, Gulf of California (x 1.6)
28 - *C. dispar*, Santa Iñes Isl., Mexico, 28.8 mm (Coll. Lauer).
29 - *C. scalarissimus* da Motta, 1988: lectotype of *C. gradatus* Reeve, 1843 and holotype of *C. scalarissimus*, "Salango", 81 mm, BM(NH), London.
30 - *C. emarginatus* Reeve, 1844: lectotype-figure of *C. arcuatus* Gray, 1839 (pl.36, fig.22) (x 1.2).
31 - *C. emarginatus* Reeve, Panama, 56 mm (Coll. Lauer).

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***2) Conus gradatus* Wood, 1828**: 8, *Conus* n° 6, pl. 3, fig. 6*b* (FIG. 13):

Wood (p. 8 n° 6) did not either give a description of his own *C. gradatus*. He only indicated its "English name": "interrupted". However, he illlustrated a specimen on pl. 3, fig. 6*b*.

Wood's figure, even if very small (17 mm high), is finely drawn, and represents a moderately elongate shell with a slightly ventricose body whorl, a straight-sided spire of 8 stepped volutions with a more or less flat to concave upper ramp. The body whorl is covered with 7 spiral alignments of brownish, more or less squarish, medium sized blotches and two intermediate alignements of fine blackish spots. The plates having been hand coloured, the colours slightly vary from one copy to another. Type locality: "California".

Wood indicates (Preface, p. iv) that a "mark or a letter of the alphabet is added after the number engraved on the plate", the letter β signifying a shell-length of about 2 inches (= approximately 57 mm). Wood's figure is hard to assign with some certainty to a known species.

In literature *C. gradatus* (see *C. gradatus* Reeve, n° 10) has been most often considered as being the taxon Reeve introduced in 1843 (with a strongly stepped spire and a straight sided, to slightly concave body whorl), or confused with forms of *C. regularis* Sowerby 1833. The difficulty to determine what a "real" species Wood intended to denote is, among others, pointed out by following authors:

- KEEN (1958: 486), under the name *C. gradatus* Wood, figured a shell (p. 487, fig. 939) she later considered (1971: p. 666, n° 1506) a specimen of *C. recurvus* Broderip, 1833 (which is here assigned to *C. gradatus* Reeve (= *C. scalarissimus* da Motta). Also in 1971 (p. 665) she noted "Until the type" (of *C. gradatus* Wood) "is detected and studied, it seems wisest to regard the species as indeterminate and to utilize for the complex of which it might be a member a name based on well-figured type material".

- EMERSON & OLD (1962: 22) noted: "*C. gradatus* of Wood, 1828, as has often been pointed out, is the earliest name available for this complex. However, until the holotype is critically examined and is refigured, it is best considered a *species inquirendae* and is referred here questionably to the synonymy of *Conus regularis* Sowerby, 1833." The authors figured (p. 21: fig. 9) a specimen of *C. monilifer* Sowerby, 1833 under the name of *C. gradatus* Wood, nevertheless with a question mark.

- COOMANS *et al.* (1980: 40 (*angulatus*)) considered the identity of *C. gradatus* Wood as "still questionable at the moment".

- DA MOTTA, (1989: 9) held it as a valid species, designated Wood's fig. 6*b* as representative of the lectotype, and noticed that *C. gradatus* might be recognized in the shells Walls figured on p. 341, "bottom left frame: both figures; and bottom right frame: the two figures in the lower row". His distinction from other Cones of this groupe was largely based on the straight sided spire profile and strongly stepped whorls.

- KOHN (1992: 218) concluded as follows: "Because this figure" (Wood's one) is so small (17mm) and so crude, it is not possible to assign it unequivocally to any known species. I thus conclude that *C. gradatus* Wood, 1828 is a *nomen dubium*." I provisionally agree with both, KEEN (1971) and KOHN (1992) in reaching the same conclusion.

Figures 32 to 43 (opposite page)

32 - *C. candidus* Kiener, 1845: lectotype-figures in Kiener, pl.97, fig.1 (x 1.4).

33 - *C. angulatus* A.Adams, 1853 (= *C. regularis*): holotype, 40 mm, BM(NH), London.

34 - *C. scariphus* Dall, 1910: holotype, Cocos Island, 41 mm, USNM, Washington.

35 - *C. magdalenensis* Bartsch & Rehder, 1939 (= *C. incurvus*): holotype, Magdalena Bay, 33.6 mm, USNM, Washington.

36 - *C. gradatus thaanumi* Schwengel, 1955 (=*C. incurvus* ?), Bahia Salinas: syntypes-figures, pl.2, figs.12-13, 47 and 39 mm.

37 - *C. gradatus thaanumi* Schwengel: "holotype", 45.5 mm, USNM, Washington (After Hanna).

38 - *C. recurvus helenae* Schwengel, 1955 (= *C. incurvus*), Curu: syntypes-figures, pl.2, figs.14-15, 44 and 36 mm.

39 - *C. recurvus helenae* Schwengel: "holotype", 45.2 mm, USNM, Washington (After Hanna).

40-41: *C. poormani* Berry, 1968: Panama, 50.1 mm - Las Perlas Isl., 45.5 mm. (Coll. Lauer).

42-43 - *Conus species* n° 1: Punta Eugenia, Baja California, 40 mm and Galapagos, 49.8 mm (Coll. Lauer).

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3) *Conus regularis* Sowerby, 1833 (17 May, Part 29, fig. 29) (Fig. 14):
- *C. regularis* (valid) - SOWERBY II: 1857: 16, pl. 9, figs. 208-210.
- *C. regularis* (valid) - DALL, 1910: 221-222- no figure.
- *C. regularis* (valid) - KEEN, 1958: 486, fig. 941.
- *C. regularis* (valid) - EMERSON & OLD, 1962: 20-23, fig. 7.
- *C. regularis* (valid) - HANNA, 1963: 29; pl. 2, fig. 2; pl .6, fig. 5.
- *C. regularis* (valid) - KEEN, 1971: 665, 666, fig. 1507 (only right).
- "*C. regularis*" (=*C. incurvus*) - NYBAKKEN, 1971: 104; 102, fig. 18 (fig. 19 unidentified).
- *C. regularis* (valid) - MARSH & RIPPINGALE, 1974: 63; pl. 7 fig. 21.
- "*C. regularis*" (= *C. recurvus*) - KAICHER, 1977, II, Card 1327.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527; 531; (340-341, 344 see below).
- *C. regularis* (valid) - DA MOTTA,1989: 9.
- *C. regularis* (valid) - RICHARD, 1990: 181.
- *C. regularis* (valid) - KOHN, 1992: 243-244.

No type-specimen being available, DA MOTTA (1989: 6) designated the figure in Sowerby as representative of the holotype of *C. regularis*. In accordance with the "Code" (Art. 74b) Da Motta's designation should be considered of a lectotype and not of a holotype. In addition, the availability of this designation as a nomenclatural act is questionable. KOHN (1992: 243-244) correctly designated the same figure as "representation of the lectotype".

Sowerby I gave neither a diagnosis nor a description in his "Conchological Illustrations". BRODERIP (1833,-24 May) makes no mention of *C. regularis*. For this reason KOHN (1992: 247) referred to the diagnosis and description given by SOWERBY II in 1857 (p. 16, n° 128):

Diagnosis: "*C. subturbinatus, laevis, lateribus subcontractis; maculis quadratis rubro-nigrescentibus regulariter fasciatim pictus; spirâ acuminatâ, lateribus incurvis*". (C. subturbinate, smooth, with subcontracted sides; squarish blackish-red dots regularly arranged in fascies. Pointed spire with incurved sides.)

Description: "Broader at the upper angle than the preceeding ("*C. incurvus*" = *C. recurvus*) and marked with regular, square, reddish-brown spots."

Sowerby II gave three figures (pl. 9, figs. 208-210) for *C. regularis*, which rather well illustrate the variability of the species. Although Sowerby I did not indicate a type locality, Sowerby II localized the species in: "Bay of Nicoya, Central America, etc, Bay of Panama, *Cum*." KIENER (1845: pl. 25, figs 3, 3a) also illustrated two different "varieties" of this species which he considered valid.

C. regularis (FIGS. 15) is a well known species, of which further description appears unnecessary, and a large majority of authors (REEVE, 1843, SOWERBY, 1857, TRYON, 1884, DALL, 1910, TOMLIN, 1937, etc.) held it as valid. KEEN (1958: 486, n° 941; 1971: 665, n° 1507) gave an exhaustive list of synonyms: *C. monilifer* "Broderip", *C. syriacus* Sowerby, *C. angulatus* Adams, ? *C. gradatus thaanumi* Schwengel. In 1971, she added *C. magdalenensis* Bartsch & Rehder and *C. recurvus helenae* Schwengel. (See these taxa below). HANNA (1963: pl. 2, fig. 2; pl. 6, fig. 5; pl. 9 fig. 9) published three colour photographs of *C. regularis* of which pl. 9 fig. 9 is here assigned to *C. recurvus* Broderip. NYBBAKEN's study on radular teeth (1971) in this group is of little help for identification of closely patterned *Conus*, because he adopted the partly erroneous determinations from HANNA & STRONG (1949), KEEN (1958) and HANNA (1963). For example, he figured (1971: 102, figs. 18-19) under the name *C. regularis* four specimens which in my opinion belong to *C. incurvus*. Strangely WALLS (1979: 527) synonymised *C. regularis* with "*C. gradatus* Wood" of which he considered *C. regularis* as "the more typical lower-spired form" and illustrated it on p. 341 above left, and at the bottom, extreme right of the second row. Successively RICHARD (1990: 181) and KOHN (1992: 244) considered *C. regularis* a valid species, opinion which is here agreed with.

4) *Conus monilifer* Sowerby in Broderip, 1833 (24 May: 54), *Conchological Illustrations, part 29*, fig. 37. (Figs 16-18):
- *C. monilifer* (valid) - SOWERBY II: 1857: 14 n° 109; pl. 16 fig. 380 - fig. 381 unidentifiable, fig. 382: probably *C. incurvus*.
- *C. monilifer* (valid) - DALL, 1910: 222 - no figure.
- synonym of *C. regularis* - TOMLIN, 1937: 278.
- synonym of *C. regularis* - KEEN, 1958: 486.
- "*C. regularis* form *monilifer*" - EMERSON & OLD, 1962: 21, fig. 9; 23.
- synonym of *C. regularis* - HANNA, 1963: 30.
- synonym of *C. regularis* - KEEN, 1971: 665.
- synonym of *C. gradatus* Wood - WALLS, 1979: 527, 534.
- *C. monilifer* (valid) - DA MOTTA, 1989: 9.
- *C. monilifer* (valid) - RICHARD, 1990: 170.

- tentatively synonym of *C. regularis* - KOHN, 1992: 245.

DA MOTTA (1989:6) selected and figured (p. 7), from four specimens preserved in the BM(NH), the specimen measuring 50 x 22 mm as the lectotype of *C. monilifer* (FIG. 17). KOHN (1992: 245) designated the same specimen as the lectotype (see abowe the comment on the type of *C. regularis*).

Original diagnosis (in Broderip, 24 May 1833: 54): "*Con. testâ subfusiformi, transversim striatâ, albicante, castaneo-variegatâ, punctis castaneis seriatim ordinatis; spirâ acuminatâ, albo castaneoque variâ, apice acuto: long.2, lat.11/12 poll.*" (Cone shell subfusiform, transversally striate, whitish, varied with chestnut, with serially disposed chestnut spots; spire acuminate, varied with white and chestnut, sharp apex: long: 2, width:11/12 inch. (50.8 x 23.3 mm)).

Type locality: "Salango", "dredged at a depth of nine fathoms in sandy mud. A single specimen. - G.B.S.". Salango (today Salanga isl.) is a little island in the vicinity of López, Ecuador)

SOWERBY II (1857: 14, n° 109) gave a second diagnosis and description:

Diagnosis: "*C.solidus, subfusiformis, infra contractus, punctis articulatis castaneis cinctus flammeisque variegatus; spirâ acuminatâ.*" (Solid Cone, subfusiform, contracted towards the base, encircled with articulate chestnut points which are mixed with flames; acuminate spire.)

Description: "Distinguished by the articulated rows of semicircular spots by which all the varieties are more or less encircled."

To the preceding diagnoses and descriptions should be added that the lectotype has a slightly bulbous shoulder with a relatively rounded angle, an elevated, sharp, but not scalar spire with feebly stepped whorls, the earlier ones being more strongly gradate, a smooth body whorl constricted towards the base. All these characters are sufficient to distinguish *C. monilifer* from its congeners. Even if it is close to *C. incurvus* in general shape [what seemingly had somewhat disturbed Sowerby II in his fig. 381 and 382 (pl. 16)], the higher spire of 11 to 12 visible volutions with a strongly steep upper ramp and a more rounded shoulder in *C. monilifer*, and its rather peculiar colour pattern, allow separation of both species. *C. monilifer* is here considered a valid species (FIGS. 16-18).

Figs.44 - *Conus species* n° 2: Bahia Santa Iñes, Baja California, respectively 33.8, 35.7, 33.8 and 33.9 mm. (Coll. Lauer).

5) *Conus recurvus* Broderip, 1833 (24 May:) (FIGS. 19-21):

- "*C. incurvus*" - SOWERBY II: 1957: pl. 9 fig. 194. - the name *recurvus* was not mentioned by Sowerby II (FIG. 20).
- not mentioned by DALL, 1910.
- "*C. recurvus*" (= *C. emarginatus*) - EMERSON & OLD, 1962: 16-17, fig. 3.
- "*C. recurvus*" (= *C. emarginatus*) - KEEN, 1958: 487, fig. 940.
- "*C. recurvus*" (= *C. emarginatus*) - HANNA, 1963: pl. 1, fig. 3; pl. 2, fig. 7.
- "*C. recurvus*" (= *C. scalarissimus*) - KEEN, 1971: 665, fig. 1506.
- "*C. recurvus*" (= *C. emarginatus*) in NYBBAKEN (1971: 98, fig. 13; 102, figs. 14-17.
- "*C. recurvus*" (= *C. emarginatus*) - MARSH & RIPPINGALE, 1974: pl. 7, fig. 20.
- "*C. recurvus*" (= *C. emarginatus*) - KAICHER, 1977, II, Card 1160.
- "*C. recurvus*" (= *C. emarginatus*) - WALLS, 1979: 577, above and below right.
- synonym of *C. regularis* - COOMANS *et al.*, 1981, 4: 13-14 (under *arcuatus* Gray).
- synonym of *C. regularis* (form) - DA MOTTA, 1989: 9.
- synonym of *C. emarginatus* - RICHARD, 1990: 180.
- synonym of *C. regularis* (tentatively) - KOHN, 1992: 246.

Original diagnosis (p. 54): "*Con.testâ elongato-conicâ, subrecurvâ, albâ rubro-castaneo nebulosâ et vittatim punctatâ; spirâ prominente, acutâ albo castaneoque maculatâ; epidermide tenuissimâ: long.2, lat.7/8 poll.- Hab.* in Americâ Meridionali. (Monte Christi)" (Cone, shell elongate-conical, somewhat incurved, suffused with pale reddish chestnut and showing punctuated bands; spire prominent, sharp, white and chestnut stained; very thin epidermis (periostracum) - Lives in Southern America, Monte Christi (Today: Manta, near Cape San Lorenzo, Ecuador): length 2, width 7/8 inches (= 50.8 x 22.2 mm).

Original description: "In young specimens the top of the body whorl, just as it joins the spire, is surrounded by a thin elevated edge. This, in young individuals, is almost sharp: with age all traces of it disappear. In its markings it sometimes resembles *Conus amadis*. - Found in gravel at a depth of twenty-two fathoms".

Although DA MOTTA (1989: 6) stated that the holotype was preserved in the BM(NH), KOHN (1992: 246), noticing that this specimen was certainly not the sole Broderip had studied, and according with the "Code", designated this specimen (53 x 23 mm) as the lectotype of *C. recurvus* Broderip (FIG. 19).

The lectotype has an elongate body whorl, somewhat concavely incurved in its lower third, with a narrow aperture. The medium-high spire, of 11 visible, slightly depressed volutions, has a nearly straight to weakly concave profile. The whole of the body whorl is patterned with spiral rows of chestnut more or less squarish and axially elongate dots, suffused by some axial flammules of a lighter chestnut, and sometimes separated by spiral alignments of minute chestnut spots. The spire is stained whith analogous white and chestnut articulate dots (FIG. 21).

C. recurvus is here tentatively considered as a valid species.

6) *Conus incurvus* Sowerby, 1833 (June or July, Part 33, fig. 36) (Figs. 22-24):

- "*C. recurvus*" - KIENER, 1845 : pl. 97 figs. 4-4a.
- "*C. incurvus*" (= *C. recurvus*) - SOWERBY II: 1857: 127, pl. 9 fig. 194 (FIG. 20).
- "*C. incurvus*" - DALL, 1910: 222: unidentified, no figure.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - KEEN, 1958: 486, fig. 940.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - EMERSON & OLD, 1962: 16-17, but figured p. 19 fig. 6 as "*C.* cf. *magdalenensis* B. & Rehder").
- "*C. recurvus*" (= *C. emarginatus* Reeve) - HANNA, 1963: 27.
- synonym of "*C. recurvus*" (= *C. scalarissimus*) - KEEN, 1971: 665, fig. 1506.
- synonym of "*C. recurvus*" (= *C. emarginatus* Reeve) - WALLS, 1979: 829, 831.
- synonym of *C. emarginatus* - RICHARD, 1990: 162.
- synonym of *C. regularis* (tentatively) - KOHN, 1992: 247.

Sowerby I gave neither a diagnosis nor a description in his "Conchological Illustrations". For this reason KOHN (1992: 247) referred to the diagnosis and description given by Sowerby II in 1857 (p. 16, n° 127):

Diagnosis: "*C. attenuatus, laevis, coerulens, rubronigrescente seriatim maculatus; lateribus incurvis, spirâ acuminatâ, gradatim angulatâ.*" (Shell slender, smooth, bluish, with blackish-red series of dashes; incurved sides, pointed spire with angular gradations."

English description: "Longer than *C. dispar*, with the sides elegantly incurved."

However Sowerby's II diagnosis and description are the ones of the specimen he illustrated on pl. 9, fig. 194, which is *C. recurvus* and most probably drawn after the lectotype of this species. Thus his text is of no help in the identification of *C. incurvus*.

Sowerby only indicated the type locality: "Monte-Christe" (see above under *C. recurvus*)

Sowerby's I figure n° 36 (FIG. 22) was designated as "representation of the lectotype" of *C. incurvus* by KOHN (1992: 247, fig. 483). This figure shows an elongate shell with straight to sligthly concave body whorl sides, a rather high and slightly concave spire of 10 visible volutions with a weakly depressed upper ramp bordered with a moderately elevated bank. The earlier whorls are more strongly stepped. Near the base, seven faint oblique spiral sulci are visible. The colour pattern consists of some spiral arrangements of brown dots on more or less zigzaging axial orange-brownish flames. In its whole, the pattern is close to the one of *C. regularis*. However, with its less broad shouldering and higher, more concave spire, *C. incurvus* is rather easy to separate from *C. regularis*. I tentatively consider it as a separate valid species.

7) *Conus syriacus* Sowerby, 1833 (Post July, Part 36, fig. 45) (FIG. 25):
- synonym of *C. regularis* - SOWERBY I 1841: Index.
- synonym of *C. regularis* - KEEN, 1958: 486; 1971: 665.
- synonym of *C. regularis* - HANNA, 1963: 30.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527; 534.
- synonym of *C. regularis* - DA MOTTA, 1989: 1, fig. 3; 6.
- Tentatively synonym of "*C. regularis* ?" - RICHARD, 1990: 187.
- synonym of *C. regularis* - KOHN, 1992: 248.

C. syriacus is a junior homonym of *C. syriacus* (Röding, 1798) (= *C. spurius* Gmelin, 1791), thus invalid. Sowerby I himself in his "Index" of the "Conchological Illustrations" (1841) changed the name to "*C. regularis* Nob. Z.P.1841". No type specimen being available, Kohn (1992: 248, fig. 485) designated the original figure 45, in Part 36 (48 x 22 mm) "as representation of the lectotype" (FIG. 25). Type locality: none. The lectotype-figure confirms Sowerby's I second opinion and shows a specimen of a light-patterned form of *C. regularis*. Thus *C. syriacus* is considered as a synonym of *C. regularis*, as it was already stated by KOHN (1992).

8) *Conus dispar* Sowerby, 1933 (Post July, Part 37, fig. 57) (Figs. 26-28):
- *C. dispar* (valid) - REEVE, 1849: pl. 4, fig. 238.
- *C. dispar* (valid) - SOWERBY II, 1857: 16 n° 126, pl. 9, fig. 195 (= *C. recurvus* ?).
- C. *dispar* (valid) - DALL, 1910: 222 - no figure.
- C. *dispar* (valid) - KEEN, 1958: 485, fig. 937.
- *C. regularis* forma *dispar* (tentativ.) - EMERSON & OLD, 1962: 20-21, fig. 10.
- *C. dispar* (valid) - HANNA, 1963: pl. 7 fig. 18, and maybe pl. 3, fig. 11 as "*scalaris* Valenciennes".
- *C. dispar* (valid) - NYBAKKEN, 1970: 17, fig.25.
- Tentatively synonym of "*C. scalaris* ?, variant" - KEEN, 1971: 667.
- *C. dispar* (valid) - MARSH & RIPPINGALE, 1974: pl. 7 fig. 22, whose identity is questionable).
- *C. dispar* (valid) - KAICHER, 1977, II, Card 1126 - an outstanding figuration.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527, 531 (fig. which is *C. dispar*), 534.
- *nomen dubium* - COOMANS *et al.*, 1985, 8: 171, fig. 647.
- *nomen dubium* - DA MOTTA, 1989: 6.
- *C. dispar* (valid) - RICHARD, 1990: 153.
- *C. dispar* (tentatively valid) - KOHN, 1992: 249.

Sowerby I gave neither a diagnosis nor a description of *C. dispar* in his "Conchological Illustrations". No type-locality has been mentioned. As a substitute, KOHN (1992: 249) cites the ones of Sowerby II (1857: 16, n° 126). However, in pl. 9, the fig. 190 which Sowerby assigned to this species does not match with the type-figure and cannot be unequivocally attributed to this species. Kohn admitted this when he wrote: "the diagnosis and figure in the *Thesaurus* almost certainly apply to a different species from that illustrated in *The Conchological Illustrations*" (1992: 249), and designated (fig. 489) Sowerby's I original figure (part 37, fig. 57 - 22 x 9 mm) "as representation of the lectotype" (FIG. 26). This lectotype-figure is rather crude, and the species should be definitely fixed by the designation of a neotype. I agree with Keen's, Hanna's and Kaicher's concept of *C. dispar*, which is very well figured in Kaicher's card n° 1126 (FIG. 27). *C. dispar* is a rather small species (30 to 38 mm), with a moderately high and feebly concave spire of about 8 to 9 flat, nearly unstepped teleoconch whorls of which the two last ones show three

weak spiral sulci. Such sulci are rarely observed in this group. The body whorl has nearly straight sides, the aperture is narrow and does not enlarge towards the base. The shell is white, partly suffused by light tan to bluish-tan, more or less large and undefined dashes, and encircled by alignements of chestnut to orange-brown spots. The spire is sparsely stained with dark brown markings. *Conus dispar* is here considerd a valid, seemingly rather rare species which occurs in the Gulf of California (Keen, Hanna, Kaicher) (FIG. 28). *C. dispar* is sometimes confused with *C. species* n° 2 (FIG. 44), which has a strongly concave spire of 10 stepped teleoconch whorls.

9) *Conus arcuatus* Gray, 1839 (119; pl. 36, fig. 22) (FIG. 30):

The name being a junior homonym of *C. arcuatus* Broderip & Sowerby, 1829, another valid species belonging to the subgenus *Conasprella* Thiele, 1929, the species was redescribed by REEVE (1844, pl. 43 fig. 232) as *C. emarginatus*. (See hereunder: *C. emarginatus* Reeve.)

10) *Conus gradatus* Reeve, 1843 (pl. 25, fig. 140) (FIGS. 2, 29):

- *C. gradatus* Reeve (= *C. scalarissimus*) - KIENER, 1845: 140-141, pl. 94, fig. 6, which is probably taken from Reeve).
- synonym of "*C. scalaris* Valenc. " (= *C. scalarissimus*) - SOWERBY II, 1857: pl. 9, fig. 192, which is a reproduction of Reeve's figure.
- "*C. scalaris*" (= *C. scalarissimus*) - TRYON, 1884: pl. 10, fig. 83, which is a reproduction of Reeve's (n° 140) or of Sowerby's (n° 192) figure.
- "*C. gradatus* Mawe" (?) - DALL, 1910: 221.
- "*C. gradatus* Wood" (= *C. scalarissimus*) - KEEN, 1958: 486; 487, fig. 939.
- "*C. scalaris* Valenc " (= *scalarissimus* Da Motta ?) - EMERSON & OLD, 1962: 24, fig. 12 ?.
- "*C. gradatus* Mawe" (= *C. scalarissimus*) - HANNA, 1963 :pl. 2 fig. 3.
- "*C. gradatus* Mawe" (= *C. scalarissimus* ?) - NYBAKKEN, 1970: 15, fig. 23 (radula).
- "*C. gradatus* Mawe" (= *C. incurvus*) - NYBAKKEN, 1971: 99-100; 98, fig. 6.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527.
- *C. scalarissimus* - DA MOTTA, 1988: 47.
- *C. scalarissimus* - DA MOTTA, 1989: 6-9.

C. gradatus Reeve, 1843, being a junior homonym of *C. gradatus* Wood, 1828, was renamed *C. scalarissimus* Da Motta, 1988, *nomen novum*. Its lectotype (Reeve himself stated that he had seen several specimens when he described this taxon) is kept in BM(NH) and is the (originally designated) holotype of *C. scalarissimus* Da Motta (81 x 35 mm) (FIG. 29).

Diagnosis: "*Con. testâ elongato-turbinatâ, laeviusculâ, albidâ, rubido-fusco longitudinaliter inquinatâ; spirâ turrido-exsertâ; apice valdè elato*".

Description (which is a literal translation of the diagnosis): " Shell elongately turbinated, rather smooth, whitish, longitudinally bedaubed with reddish-brown; spire exserted in the form of a turret; apex very elevated. - Gray, MSS., British Museum." (The indication: "Gray MSS." refers to a manuscript kept in BM(NH) which was never published in the sense of the "Code", so that Reeve must be considered as the author who made the name available.)

Type locality: "*Hab.* Salango, South America (found on the sands; Cuming." (Salanga Isl. near López, Ecuador)).

Reeve added: " I have seen several specimens of this remarkable shell, each exhibiting the same peculiarly turreted spire, and the same exact style of painting. It approximates in its general outline to the *Conus generalis*, and is certainly very closely allied to it; I cannot however agree with my excellent friend the Rev. Stainforth, in considering it to be a monstrosity of that species." (Comments of plate 25). Sowerby II too (1857: 14, n° 106: "*C. scalaris* Valenc. ") tentatively expressed such an opinion when he wrote: "the whorls (*accidentally* ?) gradated."

C. scalarissimus is a large-sized species with a rather strongly concave and elevated spire of 9 visible volutions which are strongly stepped, and which have a depressed profile bordered with a rising, slightly rounded external bank. It can hardly be confused with other species of the group. *C. scalarissmus* da Motta, 1988 (nomen novum for *C. gradatus* Reeve, 1843) is here considered as a valid species which occurs in Baja California and Mexico.

11) *Conus emarginatus* Reeve, 1844: pl. 43 spec. 232 (FIGS. 30-31):

- "*C. arcuatus* - Brod. & Sow. Zool. Journ. iv 379" - GRAY, 1839: 119, pl. 36 fig. 22.
- *C. emarginatus* (valid) - SOWERBY II, 1857: 15 n° 115; pl. 16, fig. 387.
- *C. emarginatus* (valid) - DALL, 1910: 221-222.

- "*C. recurvus*" (synon.:*C. emarginatus*)" - KEEN, 1958: 486, fig. 940.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - EMERSON & OLD, 1962: 17; 17 fig. 3.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - HANNA, 1963: 27, 41; pl. 1, fig. 3; pl. 2, fig. 7.
- "*C. recurvus*"(= *C. emarginatus*) - NYBAKKEN, 1970: 6; 8, fig. (radula); 23, figs. 35-39.
- "*C. recurvus*" (= *C. emarginatus*) - NYBAKKEN, 1971: 101-104, figs. 14-17.
- synonym of "*C. recurvus*" (= *C. scalarissimus*) but not figured - KEEN, 1971: 665.
- "*C. recurvus*" - MARSH & RIPPINGALE, 1974: pl. 7, fig. 20; p. 141.
- synonym of "*C. recurvus*" - WALLS, 1979: 829, 831; 577: all figures.
- *C. emarginatus* (valid) - COOMANS *et al.*, 1986, 6: 112-113, fig. 720.
- *C. emarginatus* (valid) - RICHARD, 1990: 154.
- *C. emarginatus* (valid) - KOHN, 1992: 273-274, fig. 547 - *C. gradatus* Gray.

When Broderip & Sowerby described their *C. arcuatus*, this taxon was based on two specimens which did not belong to the same species. Reeve misinterpreted *C. arcuatus* Broderip & Sowerby, the description of which closely agrees with what today is accepted as *C. emarginatus* Reeve. (For more information, consult COOMANS *et al*, 1981, 4: 12-14; 1986, 9: 112-113, and KOHN, 1992: 220, 273-274.)

Diagnosis: "*C. testâ fusiformi, albidâ, castaneo-marmoratâ, striis et labio spiram versus marginato arcuatis; spirâ mediocri, carinatâ; epidermide tenui." 2" x 0.9"* (51 x 23 mm).(Cone fusiform, whitish, marbled with chestnut, with striae and lip arcuate next to the margin of the spire; medium spire, carinate; thin epidermis.) (BRODERIP & SOWERBY, 1829: 379)

The type-locality should also be taken from Broderip & Sowerby: "Pacific Ocean, near Mazatlan". The subsequent restriction by COOMANS *et al.* (1981:13) to "Cape San Lucas, Baja California, Mexico", as the authors themselves later stated (1986:112) is "not correct". KOHN (1992: 273, fig. 547) designated the figure in Gray (pl.36, fig.22) as "representation of the lectotype of *C. arcuatus* Gray" (FIG. 30). Therefore, *C. emarginatus* Reeve being a nomen novum of *C. arcuatus* Gray, and not a type-shell being available, the same figure should be considered as representative of the lectotype of *C. emarginatus* as well.

C. emarginatus is a rather common species which is easy to identify (FIGS. 31): spire of 11 volutions with an excavated and radially striated upper ramp and a rising margin bank. The apex is generally more or less deep tawnish. Shoulder angle sharp, body whorl with straight to sigmoid sides. Shell smooth and glossy showing strongly engraved sulci near the base, rather thin and light, whitish to creamy, covered with large axial zigzaging chestnut to deep brown flames. Spire stained whit arched brown dashes. Aperture white, outer lip sharp.

C. emarginatus is considered a valid species, occuring from Baja California to Colombia.

12) *Conus candidus* Kiener, 1845 (p. 214, spec. 183; pl .47 fig. 1) (FIGS. 32):
- synonym of *C. monilifer* - REEVE, 1849, Emendations:3.
- synonym of *C. pealii* Green - SOWERBY II: 1857: 50.
- synonym of C. pealii Green - TRYON, 1884: 36.
- synonym of *C. floridanus* Gabb - SOWERBY II, 1887: 255-256.
- synonym of *C. floridensis* Sowerby - TOMLIN, 1937: 225.
- synonym of *C. delessertii* Recluz - WALLS, 1979: 394, 398.
- *nomen dubium* and possible synonym (?) of *C. kerstitchi* Walls (= *C. selectus* Adams, 1855 ?) - COOMANS *et al.*, 1983, 6: 79.
- *C. candidus* Kiener (valid to be renamed) - RICHARD, 1990: 145.

Diagnosis: "*C. testâ elongato-turbinatâ, ad basim attenuatâ; albâ, punctis minimis fuscis regulariter seriatis; spirâ elevatâ, acutâ, variegatâ, apice fusco.*"(Cone, elongately turbinated, restricted towards the base; white with series of little, regularly disposed tawny points; spire elevate, acute, stained, apex tawny.)

Description (translated from French: " A slender shell, very constricted towards its lower part, where it seems likely nipped-in. The spire is very elevated, acuminate and pointed; One may count eleven to twelve narrowly coiled whorls, stepped, showing a well visible angle on their external part. The suture is finely marked; the last whorl is smooth all the way to the base wich offers five to six large transverse grooves. This shell is white with transverse series of very regularly spaced small brown spots. The spire is sprinkled with brown oblique blotches. The top is entirely brown coloured."

Kiener added: "This species, of a smart form, is remarkable by its transverse series of

small points with which it is ornated." Type locality: none.

No specimen(s) that may be considered as belonging to the original material is (are) today available in MNHN, nor in other Museums so that this must be considered lost. For this reason I herewith designate Kiener's original figure (1845, Pl.97 fig.1) as representation of the lectotype (31 x 13 mm) of *C. candidus* Kiener, 1845 (FIGS. 32).

Although *C. candidus* Kiener (not *C. candidus* Born, 1778) is unavailable, its specific validity remains questionable and is still under study. In addition no reliable argument allow to consider it as a West American species. However, the examination of the taxon *C. candidus* Kiener in the present paper appears judstified on grounds of its remarkable resemblance with what I hereunder call *C. species* n° 2 (FIGS. 44).

The possible synonymies advanced by successive workers, with a better knowledge of the synonymized earlier species, and a careful reading of Kiener's descripion and figure, may today be reconsidered: *C. monilifer* (syn. in Reeve) has a white apex and a pattern of very larger dots; *C. pealii* (syn. in Tryon) is a totally different species and such a synonymy cannot be longer retained; also neither *C. floridanus* Gabb nor *C. floridensis* Sowerby match with what is known of *C. candidus*. *C. delessertii* is much larger, with three spiral bands of orange-tawny and covered with very closer and larger chestnut blotches. The synonymy with *C. kerstitchi* Walls, 1978, suggested by Coomans *et al.*, should be examined more carefully, although the latter is more ventricose with a broader shoulder, shows a "yellowish (body whorl), variously tinted with salmon or salmon-tan; usually the salmon is strongest at base and below the shoulder...; early whorls faintly violet brown" (WALLS, 1979: 618). *C. candidus* Kiener is here tentatively considered a valid species, to be renamed.

13) *Conus angulatus* A. Adams, 1853 (118, n° 14) (FIG. 33):
- *C. angulatus* A. Ad. (valid) - SOWERBY II, 1857: 15, n° 113, Pl. 16, fig. 388.
- synonym of *C. regularis* - TOMLIN, 1937: 212.
- synonym of *C. regularis* - KEEN, 1958: 486.
- synonym of *C. regularis* - EMERSON & OLD, 1962: 20.
- synonym of *C. regularis* - HANNA, 1963: 30.
- synonym of *C. regularis* - KEEN, 1971: 665.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527, 534.
- synonym of *C. regularis* - COOMANS *et al.*, 1980, 3: 40.
- *C. angulatus* (valid) - DA MOTTA, 1989: 9.
- synonym of *C. regularis* - RICHARD, 1990: 139.

Original diagnosis: "*C. testa turbinato-conica, laevi, nitida, solida, alba, maculis rufescentibus variegata, maculisque rufis, in fasciis transversis dispositis, ornata; spira acuta, concava, anfractibus laevibus, anfractu ultimo postice acuteangulato; labro tenui, acuto, in medio producto, postice valdeinciso. Hab.* ? Mus.Cuming."- (C. shell pyramid-conical, smooth, glossy, solid, white mixed with russet dashes, and ornated with reddish-brown transversely arranged blotches; Spire acute, concave, whorls smooth, the last one sharply angular; lip fine, sharp, arched in the middle, strongly incised towards the base. Lives ?)

The holotype of *C. angulatus* A.Adams is preserved in BM(NH), and measures 40 x 22 mm (FIG. 33). No type locality was indicated. Da Motta (1989: 9) designated Puerto Peñasco, Sonora, West Mexico as type locality. This locality belongs to the distribution area of *C. regularis*.

After examination of the damaged and basally shortened holotype, I here agree with COOMANS *et al.* (1980) in concluding that *C. angulatus* belongs to the natural variability of *C. regularis*.

C. angulatus A.Adams, 1854 is a junior homonym of *C. angulatus* Perry, 1810, a fossil. However, being conclusively considered as a synonym of *C. regularis* Sowerby, it does not need a *nomen novum*.

14) *Conus scariphus* Dall, 1910 (225-226) (FIG. 34):
- *C. scariphus* (valid) - TOMLIN, 1937: 301.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - KEEN, 1958: 486.
- "*C. recurvus* forma *scariphus*" (= *emarginatus* f. *scariphus*) - EMERSON & OLD, 1962 :17, fig. 4; 19.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - HANNA, 1963: 27-29, pl. 5, fig. 8 (holotype))
- synonym of "*C. recurvus*" (=*C. emarginatus*) - KEEN, 1971: 665.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - WALLS, 1979: 830-831; 577, below left.
- synonym of *C. emarginatus* - RICHARD, 1990: 183.

Original description: "Shell biconic, attenuated in front, slightly swelling in front of the shoulder, which is sharply carinate; spire

low, of about eight whorls without the (lost) nucleus; the summit of the whorls between suture and carina is excavated and smooth; walls of the shell rather thin, outer lips nearly straight; ground-color yellowish white covered with a thin smooth yellowish periostracum; pattern of fluctuating longitudinal streaks of yellowish brown, which by their zigzag direction and anastomosis leave roughly triangular patches of white of small size all over the shell, except in the middle, where a tendency to the usual paler girdle is manifest; near the canal there are about sixteen paired prominent spiral threads, the intervals between the pairs being more or less channeled; sutural sinus and canal rather deep. Height of the shell 41; of shoulder 35; maximum diameter of shell 15; of canal 5 mm.

There are a few small brown spots along the shoulder keel. Though the pattern of coloration is different, the aspect of the shell recalls the Antillan *C. delessertianus*." -(= *C. delessertii* ?)- "If the white triangles were bounded by a definite dark line, this shell would approximate the pattern of the *Textile* group. As it is, it is somewhat unique in character.

Type. - Cat.N°. 123085, U.S.N.M.)" (FIG. 34)

Type locality: "Off Cocos Island, Gulf of Panama, at station 3366, in 66 fathoms, rocky bottom, one specimen with hermit crab, by the U.S. Bureau of Fisheries steamer *Albatross*."

C. scariphus is here considered belonging to the natural variability of *C. emarginatus* Reeve, as it was already stated by Hanna (who confused *C. emarginatus* with *C. recurvus*). At the most it might be considered a deep-water colour form of the latter, the zigzaging flammulated pattern being more closely interlaced, and the outline being slightly bulbous towards the shoulder, which is not observed in shallow-water specimens of the same locality.

15) *Conus magdalenensis* Bartsch & Rehder, 1939 (4, pl. 1, figs. 5 (spire), 9) (FIG. 35):
- synonym of "*C. recurvus*" (= *C. emarginatus*) - KEEN, 1958: 486.
- Synonym. or form of *C. recurvus* (= *C. emarginatus*) - EMERSON & OLD, 1962: 17-18.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - HANNA, 1963: 27, pl. 9, fig. 4 (holotype).
- synonym of *C. regularis* - KEEN, 1971: 665.
- synonym of *C. regularis* - NYBAKKEN, 1971: 104.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527, 534 (as "*magdalensis*").
- synonym of "*C. gradatus* Mawe" - RICHARD, 1990: 168.

Summary of the original description: Shell medium sized, with a rather elevated and slightly concave spire. Spire whorls ornated alternatively with dark brown and flesh colored ground color, also as the body whorl in axial "fulgurations" arrangements. Periostracum "hairy golden". Inside of the aperture bluish white. Early whorls eroded, strongly keeled in the middle with a finely nodulose margin. The keel becomes less marked on the latter whorls. Top of the whorls incised with arched striae and "some obsolete spiral striations". Rather strong low spiral cords towards the base. The holotype has 10 visible whorls. The authors add: "This cone is related to *C. regularis* Sowerby, from which it is distinguished by its higher spire and the light medium bands of the body whorl."

The holotype (FIG. 35) is preserved in USNM, n°472521, and measures 33.6 x 15.3 mm. Type locality: "It was dredged in Magdalena Bay, Lower California, in 10-15 fathoms on sandy, weedy bottom, at the entrance to the bay between Belcher Point and the anchorage."

From the description and the examination of the holotype figures, *C. magdalenensis* is here tentatively considered as belonging to the natural variability which exists between the different local populations of *C. incurvus* Sowerby, 1833.

16) *Conus gradatus thaanumi* Schwengel, 1955 (15, pl. 2, figs. 12-13) (FIGS. 36-37):
- synonym of *C. regularis*, with a question mark - KEEN, 1958: 486.
- synonym of *C. regularis* - EMERSON & OLD, 1962: 20.
- synonym of "*gradatus* Mawe" (= *C. scalarissimus*) - HANNA, 1963: 26, pl. 5, fig. 7 (holotype).
- synonym of *C. regularis*, - KEEN, 1971: 665.
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527, 534.
- synonym of "*C. gradatus* Mawe" - RICHARD, 1990: 189.

Extract from the original description:" Length 47 mm., width 21 mm. Specimens... are much more slender than *C. regularis* Sowerby, a moderate spire, neither as high as Reeve's illustration of *C. gradatus* Gray nor as flat as *C. regularis* Sowerby. They are marked with the spiral dotted lines, scarcely broken below the center for one faint band,... and with the heavy

longitudinal markings of chestnut brown of *C. gradatus* Gray". Type Locality: "Bahia Salinas, Costa Rica".

No holotype was designated in the original publication. Schwengel figured two specimens on pl.2, figs. 12 and 13, which must be considered as the syntypes (FIGS. 36). The largest one (fig. 12, 47 x 21 mm, according to Schwengel) is here designated as the lectotype of *C. gradatus thaanumi*. According to HANNA (1963: 27, 86) a "holotype" is preserved in USNM, n°617607 and measures 45.5 x 22.4 mm (FIG. 37). This specimen has a broken lip towards the base, and its measures differ, so that it is questionable if the prints in Schwengel and in Hanna represents the same shell. Whatever may be, the specimen figured in Hanna cannot be considered as the holotype ("Code", Art. 73.)

Both figures (lectotype in Schwengel and "holotype" in Hanna) show a shell with a feebly concave spire of 10 visible slightly stepped volutions. The body whorl has nearly straight sides, and is covered with sparsely spread more or less zigzaging reddish-brown flames. Structure and colour pattern strongly suggest that the shells belong to the natural variability of *C. incurvus*. Thus, provisionally, *C. gradatus thaanumi* may be considerd as a local colour form (or an "ecological race") of *C. incurvus*.

17) *Conus recurvus helenae*, Schwengel, 1955 (15, pl. 2, figs. 14-15) (FIGS. 38-39):

- synonym of "*C. gradatus* Wood" (= *C. scalarissimus*) - KEEN, 1958: 486.
- Synonym. or form of *C. regularis* - EMERSON & OLD, 1962: 20; 22, fig. 11, which is here assigned to *C. incurvus*.
- synonym of "*C. recurvus*" (= *C. emarginatus*) - HANNA, 1963: 27, pl. 5, fig. 6 (holotype) as "*C. scalaris helenae*".
- synonym of *C. regularis* - KEEN, 1971: 665, 666 fig. 1507 left (holotype).
- synonym of "*C. gradatus* Wood" - WALLS, 1979: 527, 534.
- synonym of "*C. emarginatus* ?" - RICHARD, 1990: 161.

Excerpt of the original description: "Length 44 mm., width 18 mm.... quite slender, a high spire, with slightly rounded shoulder, and no bands of white, though nearer to *C. recurvus* Broderip than any other named species. Beginning below center of body whorl are deep spiral lineations, which do not seem to be mentioned in any of the descriptions of *C. recurvus* Broderip in the various books..." Type locality: "Curu, Gulf of Nicoya, Costa Rica".

No holotype was expressely designated in the original publication, thus also here the figured shells in Schwengel must be considered as the syntypes (FIGS. 38). The largest one (fig. 14, 44 x 18 mm, according to Schwengel) is here designated as the lectotype of *C. recurvus helenae*.

A "holotype" is preserved in USNM, n°617608 or 617609 (?), according to HANNA (1963: respectively on p. 27 and p. 86), and measures 45.2 x 19.2 mm (FIG. 39). As for *C. gradatus thaanumi*, and for the same nomenclatural reasons, this specimen cannot be considered as the holotype, and it is questionable if it is the shell figured by Schwengel. The lectotype figure shows a concave spire of 9 visible, slightly stepped and nearly flat ramped volutions. Body whorl, with feebly sigmoid to nearly straight sides, is covered with reddish-brown, zigzaging axial flames. Although the type material should be reexamined, the figured shells in Schwengel provisionally are here assigned to the variability of *C. incurvus*.

18) *Conus poormani* Berry, 1968 (156-157) (FIGS. 40-41):

- *C. poormani* (valid) - NYBAKKEN, 1970: 17-18, figs. 26-27 (radula).
- *C. poormani* (valid) - NYBAKKEN, 1971: 100-101; 98, figs. 9-10.
- *C. poormani* (valid) - KEEN, 1971: 665, fig. 105.
- *C. poormani* (valid) - KAICHER, 1977, IV, card 1430.
- *C. poormani* (valid) - WALLS, 1979: 805-807; 549, all figs.
- *C. poormani* (valid) - RICHARD, 1990: 177.

Original description: "Shell of medium size, trimly conic below the sharp carina-like angle of the very high shoulder; spire low, barely yet acutely turreted by the exposed shoulder-carination, the slope distinctly concave, apex acute. Aperture narrow, of nearly constant width; labrum thin, arcuate; canal slightly produced; anal sulcus open and moderately deepened to its almost rectangular junction with the whorl above. Shell pure white inside and out, save for a variable amount of warm brown maculation, the spots mostly rather large and vertically elongate, besides often tending to a certain alignment in 2 to 3 spiral bands, the spire carrying a series of smaller spots. Periostracum soft brown, the darker shell markings showing through; cloth-like, the pile incrementally aligned and scratchy-looking under a lens, with 20 to 25 well-spaced, sparsely

fringed, spiral threads on unknown areas of the body-whorl; on the anal fasciole the increments become shaggily lamellose and more or less cut spirally, when unbroken rising on the angle to form a conspicuous fringe of fuzzy hair-like processes rather absurdly suggesting a tonsure. Alt. of holotype: 45.0, max.diam. at shoulder 21.9 mm; whorls ca. 10.8.

Type-locality: "Trawled in 24-26 fms., off Morro Colorado, Sonora Mexico."

According to NYBAKKEN's statement (1971: 100) it seems that the holotype ("type-specimen") is preserved in the Los Angeles County Museum. *C. poormani* is close to *C. emarginatus* by its general shape and colour pattern, but differs by its smooth body whorl showing a series of obsolete prominent small and separate ridges, whithout the deep engraved sulci near the base in *C. emarginatus*. The spire has 11 teleoconch whorls showing rather strong spiral grooves, which are absent in *C. emarginatus*. The species is also identifiable by its rather thick and brown periostracum with a hairy fringe around the shoulder.

As NYBAKKEN (1971: 101) noted: "It does seem strange, however, that so distinctive and relatively large a species as this one should have remained undescribed until 1968". *C. poormani* is here considerd as a valid species.

19) *Conus scalarissimus* Da Motta, 1988: 47.
Nomen novum for *C. gradatus* Reeve, 1843 (see this taxon, n° 11).

20) - *Conus species* n° 1 (FIGS. 4-6, 42-43):
- "*C. scalaris* Valenciennes" - KEEN, 1958: 486-487, fig. 942.
- "*C. scalaris* Valenciennes" - HANNA, 1963: pl. 4, figs. 1 & 2 (FIGS. 4); pl. 7, fig. 3.
- "*C. scalaris* Valenciennes" - NYBAKKEN, 1970: 15-16, fig. 24 (radula).
- "*C. scalaris* Valenciennes" - KEEN, 1971: 667; 666, fig. 1508.
- "*C. scalaris* Valenciennes" - MARSH & RIPPINGALE, 1974: pl. 23 fig. 20 (Fig. 5).
- "*C. scalaris* Valenciennes" - KAICHER, 1977, II, card 1119 (Figs. 6).
- "*C. scalaris* Valenciennes" - WALLS, 1979: 340 below, 344: all.

The true identity of *C. scalaris* having been misinterpreted by all the preceeding authors, *C. species* n° 1 was mostly confused with them in literature. This species is still under study and will be described and published later.

21) *Conus species* n° 2 (FIGS. 44):

As far as I know, this species has never been figured in literature, and is poorly known. It is today only recorded from Baja California, and is still under study.

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Abbreviations:
AMNH: American Museum of Natural History, New York, U.S.A.
BM(NH): The Natural History Museum, London, England
MNHN: Museum National d'Histoire Naturelle, Paris, France.
USNM: United States National Museum (Natural History) Washington D.C. , U.S.A.

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Pterymarchia n. gen. and *Vaughtia* n. gen., two new muricid genera (Gastropoda, Muricidae: Muricinae and Ocenebrinae).

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KEYWORDS: Gastropoda, Muricidae, Muricinae, Ocenebrinae, new genera.

ABSTRACT. Two new genera of Muricidae are named: *Pterymarchia* n. gen. and *Vaughtia* n. gen. They include species formerly classified in *Pterynotus* Swainson, 1833 (Muricinae), *Ocenebra* Gray, 1847, and *Urosalpinx* Stimpson, 1865 (Ocenebrinae). Following new synonyms are listed: *Tritonalia semidisjuncta* Turton, 1932 and *T. aedicularum* = *Vaughtia babingtoni* (Sowerby, 1892); *Ocenebra hayesi* Lorenz, 1995 = *V. jucunda* (Thiele, 1925); *Ocenebra newmanni* Lorenz, 1990 = *V. dunkeri* (Krauss, 1848); *Cominella fuscopicta* Turton, 1932 = *V. fenestrata* (Gould, 1860); *Purpura cribrosa* Krauss, 1859 = *V. scrobiculata* (Dunker, 1846).

RESUME. Deux nouveaux genres sont décrits chez les Muricidae: *Pterymarchia* n. gen. et *Vaughtia* n. gen. Ils sont composés d'espèces classées auparavant dans *Pterynotus* Swainson, 1833 (Muricinae), *Ocenebra* Gray, 1847, et *Urosalpinx* Stimpson, 1865 (Ocenebrinae). Les synonymes suivants sont cités pour la première fois: *Tritonalia semidisjuncta* Turton, 1932 et *T. aedicularum* = *Vaughtia babingtoni* (Sowerby, 1892); *Ocenebra hayesi* Lorenz, 1995 = *V. jucunda* (Thiele, 1925); *Ocenebra newmanni* Lorenz, 1990 = *V. dunkeri* (Krauss, 1848); *Cominella fuscopicta* Turton, 1932 = *V. fenestrata* (Gould, 1860); *Purpura cribrosa* Krauss, 1859 = *V. scrobiculata* (Dunker, 1846).

INTRODUCTION

The study of certain groups of species of the family Muricidae has allowed me to separate them from any known generic or subgeneric taxa. The necessity of describing two new genera in order to include these species was evident, and was decided only after careful examination of related supraspecific taxa of Muricinae and Ocenebrinae.

Abbreviations.

BMNH: Natural History Museum, London.
NM: Natal Museum, Pietermaritzburg.
RH: Roland Houart.

SYSTEMATICS

Family MURICIDAE Rafinesque, 1815
Subfamily MURICINAE Rafinesque, 1815
Pterymarchia, n. gen.

Type species: *Murex tripterus* Born, 1778: 287 (Fig. 1).

Range: Indo-West Pacific.

Other included species:

Pterynotus aparrii D'Attilio & Bertsch, 1980: 172, figs 2 a-d.
Coralliophila barclayanus H. Adams, 1873: 205, pl. 23, fig. 1.
Marchia bibbeyi Radwin & D'Attilio, 1976: 229, fig. 176.
Murex bipinnatus Reeve, 1845: pl. 2, fig. 6.
Pterynotus bouteti Houart, 1990: 9, figs 2, 4-6.
Purpura martinetana Röding, 1798: 141.

Description. Shell up to approximately 43 mm in length, spire high to very high. Spiral sculpture consisting of numerous major and minor, squamous cords. Axial sculpture on first to third or fourth teleoconch whorl of 9-11 strong, usually lamellate axial ribs; from fourth or fifth whorl, some axial lamellae changing into varices. Last whorl with 3 or 4, rarely 5, webbed varices, occasionally with a low node between each pair of varices on last whorl.

Aperture ovate; outer lip denticulate within.

Siphonal canal moderately long, attaining 26-39 % of the total shell length.

Operculum with apical nucleus.

Radula muricine: rachidian tooth with a broad, long central cusp, narrow lateral denticles, variable in number and strength,

long, broad lateral cusps, and smooth marginal area. Lateral teeth relatively large and broad (Figs 24-26).

Remarks. The species included in *Pterymarchia* have been usually classified in *Pterynotus* Swainson, 1833 or in *Marchia* Jousseaume, 1880, a synonym of the former.

The shell of *Pterymarchia* differs from *Pterynotus* in its different axial sculpture: species of *Pterynotus* have trivaricial sculpture from first, second, or third teleoconch whorl, and only 6-8 axial nodes on first and second teleoconch whorls, if not immediately trivaricial. The aperture in *Pterynotus* is smoother, rather strongly and briefly lirate within instead of denticulate; it is occasionally entirely smooth. To date, no species of *Pterynotus* are known to have more than three varices on their last whorl.

RADWIN & D'ATTILIO (1976) included the species of *Pterymarchia* in the genus *Marchia*, but the type species of *Marchia*, *Murex clavus* Kiener, 1843 (= *Murex elongatus* Lightfoot, 1786) is evidently a true species of *Pterynotus* (Fig. 2), while the superficially similar *Murex bipinnatus* has the typical *Pterymarchia* shell morphology (Fig. 3).

Species included in *Marchia* in RADWIN & D'ATTILIO (1976) but not retained in *Pterymarchia* are:

Murex elongatus Lightfoot, 1786 (a species of *Pterynotus*, see above);

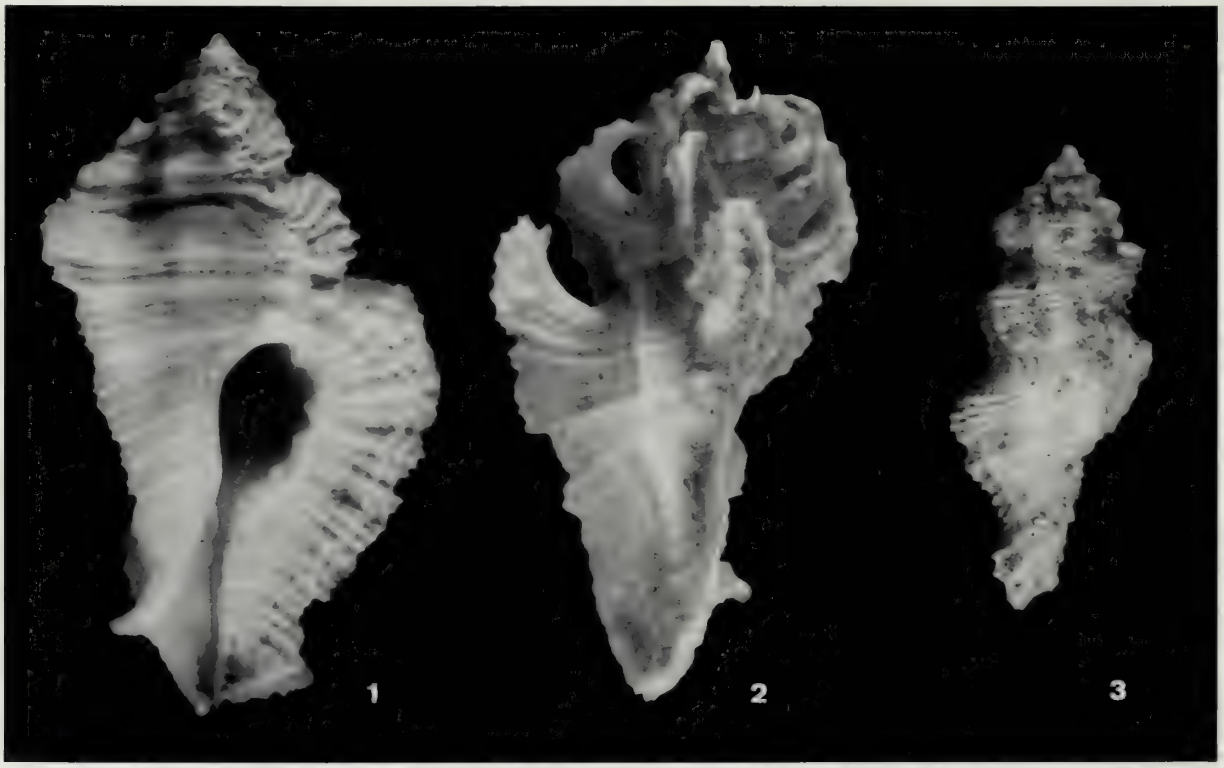
Murex laqueatus Sowerby, 1841 (a species of *Chicopinnatus* Houart, 1992);

Murex noduliferus Sowerby, 1841 (a species of *Attiliosa* Emerson, 1968);

Murex pellucidus Reeve, 1845 (a species of *Pterynotus*).

The radula of *P. bibbeyi* (Fig. 26) was illustrated by AZUMA (1973: text fig. 3) as *Pterynotus barclayanus*, while that of *P. barclayanus* was illustrated by AZUMA (1976: text fig. 2) as *Pterynotus purpureus* Azuma, 1976, a synonym.

Etymology: From *Pterynotus* and its synonym *Marchia*, two genera previously used to include the species of *Pterymarchia* n. gen.



Figures 1-3.

1. *Pterymarchia tripterus* (Born, 1778), Central Philippine Ids, coll. RH, 55.6 mm.
2. *Pterynotus elongatus* (Lightfoot, 1786), Mactan Id, Philippine Ids, coll. RH, 29.3 mm (juvenile).
3. *Pterymarchia bipinnata* (Reeve, 1846), Tuléar, Madagascar, coll. RH, 19.8 mm (juvenile).

Subfamily OCENEBRINAE Cossmann, 1903
Vaughtia n. gen.

Type species: *Murex babingtoni* Sowerby, 1892: 2, pl. 1, fig. 1.

Range: South Africa.

Other included species:
Trophon jucundus Thiele, 1925: 169, pl. 18, fig. 13.
Murex dunkeri Krauss, 1848: 112, pl. 6, fig. 14.
Peristernia fenestrata Gould, 1860: 327.
Murex purpuroides Reeve, 1845: pl. 32, fig. 158.
Fusus scrobiculatus Dunker in Philippi, 1846: 118, pl. 3, fig. 4.

Description. Shell up to approximately 17 mm in length. Spire high. Spiral sculpture strong, consisting of high major cords and occasionally one or two minor cords. Axial sculpture low. Intersection of spiral cords and axial ribs giving rise to vaulted scales or knobs.

Aperture ovate; columellar lip adherent to the shell. Siphonal canal short, open.Operculum with subterminal nucleus (Fig. 21).

Radula ocenebrine with a sickle shaped lateral tooth. Rachidian tooth bearing a short, projecting central cusp; long lateral cusps flanked by inner lateral denticle; marginal denticles and short marginal cusp (Fig. 27).

Remarks. *Vaughtia*, n.gen., differs from any other ocenebrine supraspecific taxa in its distinctive spiral and axial sculpture, added to the short, open siphonal canal. The genus appears to be endemic to South Africa. Its species have been classified in different genera, not necessary in the Muricidae, as can be seen in the synonymy. Although the species seem to be similar, they can be separated into 6. No intergrading specimens have been observed yet. A careful study of the spiral ornamentation and of other characteristics of the shell morphology permits one to separate them on the specific level.

Etymology: Named for the late Kay C. Vaught, author of "A classification of living Mollusca", and keen *Murex* collector.

Vaughtia babingtoni (Sowerby, 1892)
Figs. 4-6, 9, 22

Murex babingtoni Sowerby, 1892: 2, pl. 1, fig. 1
Tritonalia semidisjuncta Turton, 1932: 76, pl. 18, fig. 551
Tritonalia aedicularum Barnard, 1969: 640, fig. 18e

Number of spiral cords on the last whorl: 6-8. Carinal cord and next abapical cord broadest. Number of spiral cords on the shoulder: 3 cords, usually 2 major cords, and 1 minor cord near the suture (Fig. 9).

Remarks: The cords are distinct, rounded, strong; usually there is a narrow thread between the carinal cord and the next abapical cord. The last whorl is rounded or occasionally weakly angulate.

Range: Agulhas Bank to Port Alfred.

Vaughtia jucunda (Thiele, 1925)
Figs. 13-14, 17, 19, 23

Trophon jucundus Thiele, 1925: 169, pl. 18, fig. 13
Ocenebra hayesi Lorenz, 1995: 57, figs 16-19

Number of spiral cords on the last whorl: 10-12 cords, of approximately same magnitude. Number of spiral cords on the shoulder: 3, decreasing in strength adapically (Fig. 17).

Remarks: The cords are distinct, although they are lower than in *V. babingtoni*. The axial sculpture is shallow, and is more obvious between the spiral cords.

The aperture is large, broader than in any other known species of *Vaughtia*.

Range: Cape St. Blaize to Port Alfred.

Vaughtia dunkeri (Krauss, 1848)
Figs. 8, 11, 20-21, 27

Murex dunkeri Krauss, 1848: 112, pl. 6, fig. 14
Ocenebra newmanni Lorenz, 1990: 12, figs 13,14

Number of spiral cords on the last whorl: 6 or 7 broad, flat, almost smooth cords, of approximately same magnitude.
Number of spiral cords on the shoulder: Shoulder smooth (Fig. 11).

Remarks: *V. dunkeri* is similar to *V. purpuroides* and differs in its smooth shoulder, in its relatively more angulate shell, and occasionally in its fewer axial varices.

Range: Western Cape, Sea Point to Kommetje.

Vaughtia fenestrata (Gould, 1860)
Figs. 15, 18

Peristernia fenestrata Gould, 1860: 327
Cominella puncturata Sowerby, 1886: 2
Cominella puncturata bipartita Turton, 1932: 53, pl. 12, fig. 394
Cominella fuscopicta Turton, 1932: 53, pl. 12, fig. 395

Number of spiral cords on the last whorl: 15-17.

Number of spiral cords on the shoulder: 6 (Fig. 18).

Remarks: The spiral cords are flat and crowded. The carinal cord and the next abapical cord are broader.

Range: False Bay to Port Alfred.

Vaughtia purpuroides (Reeve, 1845)
Figs. 7, 10

Murex purpuroides Reeve, 1845: pl. 32, fig. 158

Number of spiral cords on the last whorl: 8 or 9. Number of spiral cords on the shoulder: 2, rarely 3 (Fig. 10).

Remarks: The shoulder cords are narrower than the other cords.

Range: Saldanha Bay to False Bay.

Vaughtia scrobiculata (Dunker, 1846)
Figs. 12, 16, 28-33

Fusus scrobiculatus Dunker *in* Philippi, 1846: 118, pl. 3, fig. 4
Purpura cribrosa Krauss *in* Küster, 1859: 166, pl. 27, figs 5-6
Murex crawfordi Sowerby, 1892: 2, pl. 1, fig. 2

Number of spiral cords on the last whorl: 6 or 7. Number of spiral cords on the shoulder: 1, occasionally 2 (Fig. 16).

Remarks: The spiral cords are broad and high, usually with vaulted scales, rarely with a small thread between them. The shell is more rounded than *V. purpuroides* and has a smooth aperture, whereas *V. purpuroides* has denticles within the outer lip. In the Transkei occurs an abnormal form (monstrosity) of *V. scrobiculata* (Figs 28-33), already mentioned in KILBURN & RIPPEY (1982: 82) and in LORENZ (1995: 57). The last whorl of the shell is globular, the suture is deeply channeled, and the spiral sculpture is weak. In the extensive material of the Natal Museum, I could observe intermediate specimens, from almost normal shells with strong spiral cords, but already more inflated last whorl (Fig. 28), to almost smooth, globular shells with deeply channeled suture (Figs 32-33). The reason of this monstrosity is still unknown.

Range: Saldanha Bay to eastern Transkei.

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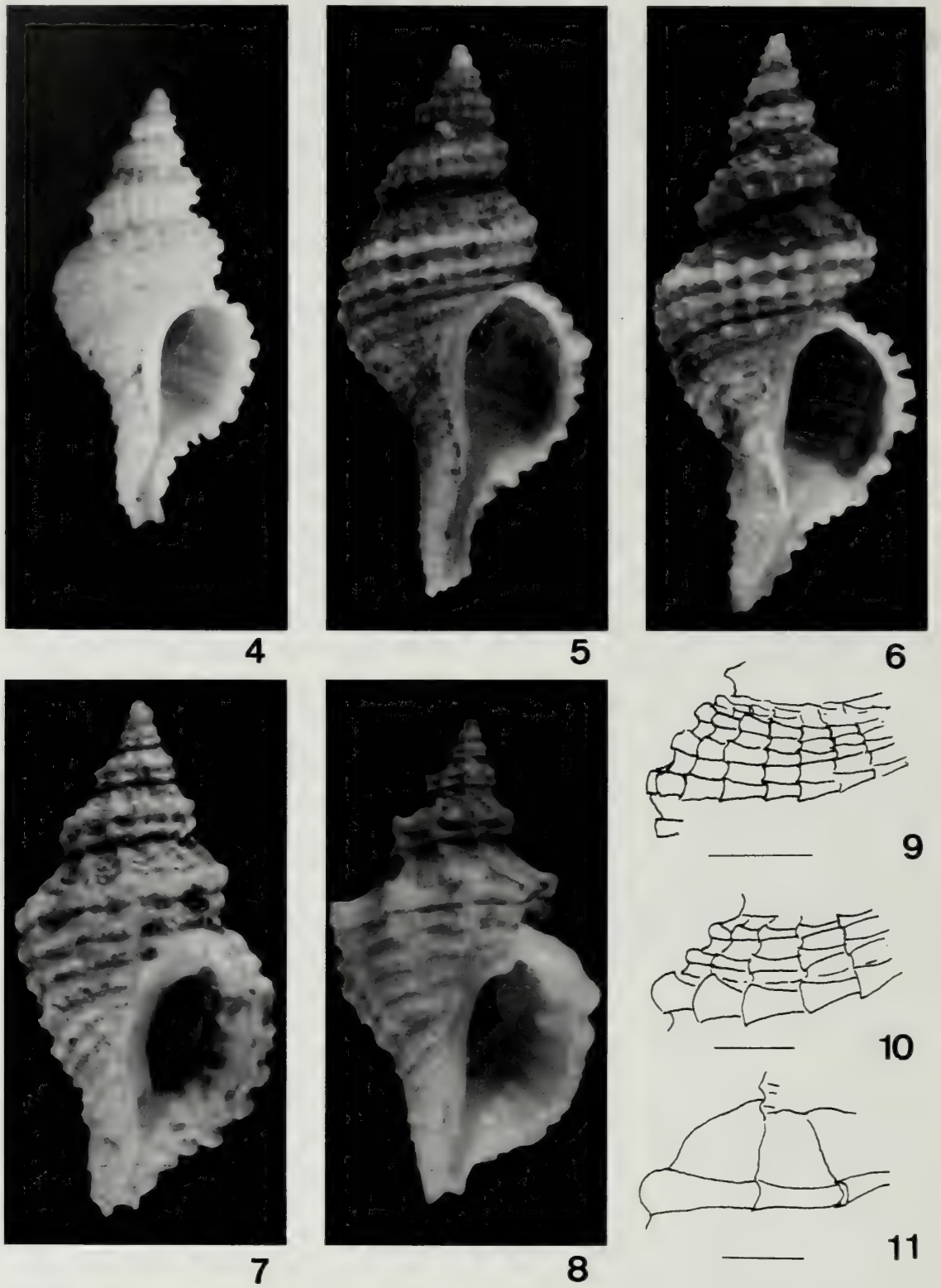

Figures 4-11

4-6 *Vaughtia babingtoni* (Sowerby, 1892). 4. Port Elizabeth, South Africa, holotype BMNH 99.4.14.3687, 15.5 mm. 5. Mossel Bay, South Africa, coll. RH, 15.3 mm. 6. Port Elizabeth, South Africa, coll. RH, 16 mm.

7. *V. purpuroides* (Reeve, 1845), West coast of Cape Peninsula, South Africa, coll. RH, 13.1 mm.

8. *V. dunkeri* (Krauss, 1848), Hout Bay, West coast of Cape Peninsula, South Africa, coll. RH, 13.4 mm.

9-11. Detail of shoulder sculpture (scale bar: 2 mm). 9. *V. babingtoni*; 10. *V. purpuroides*; 11. *V. dunkeri*.

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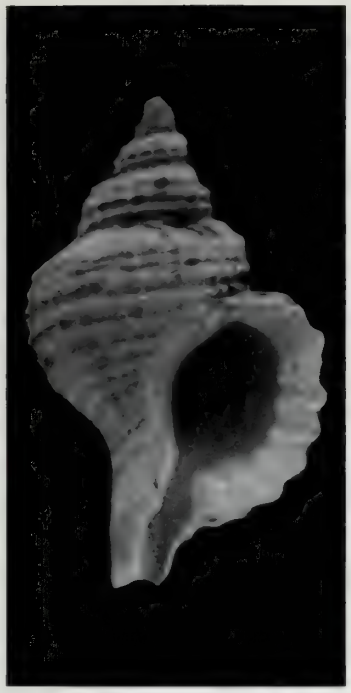

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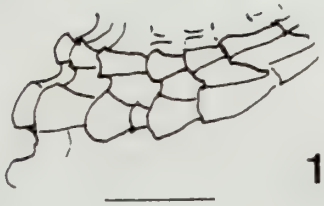

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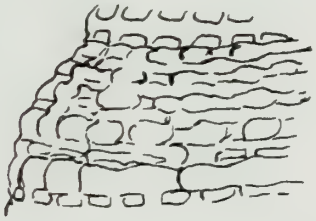

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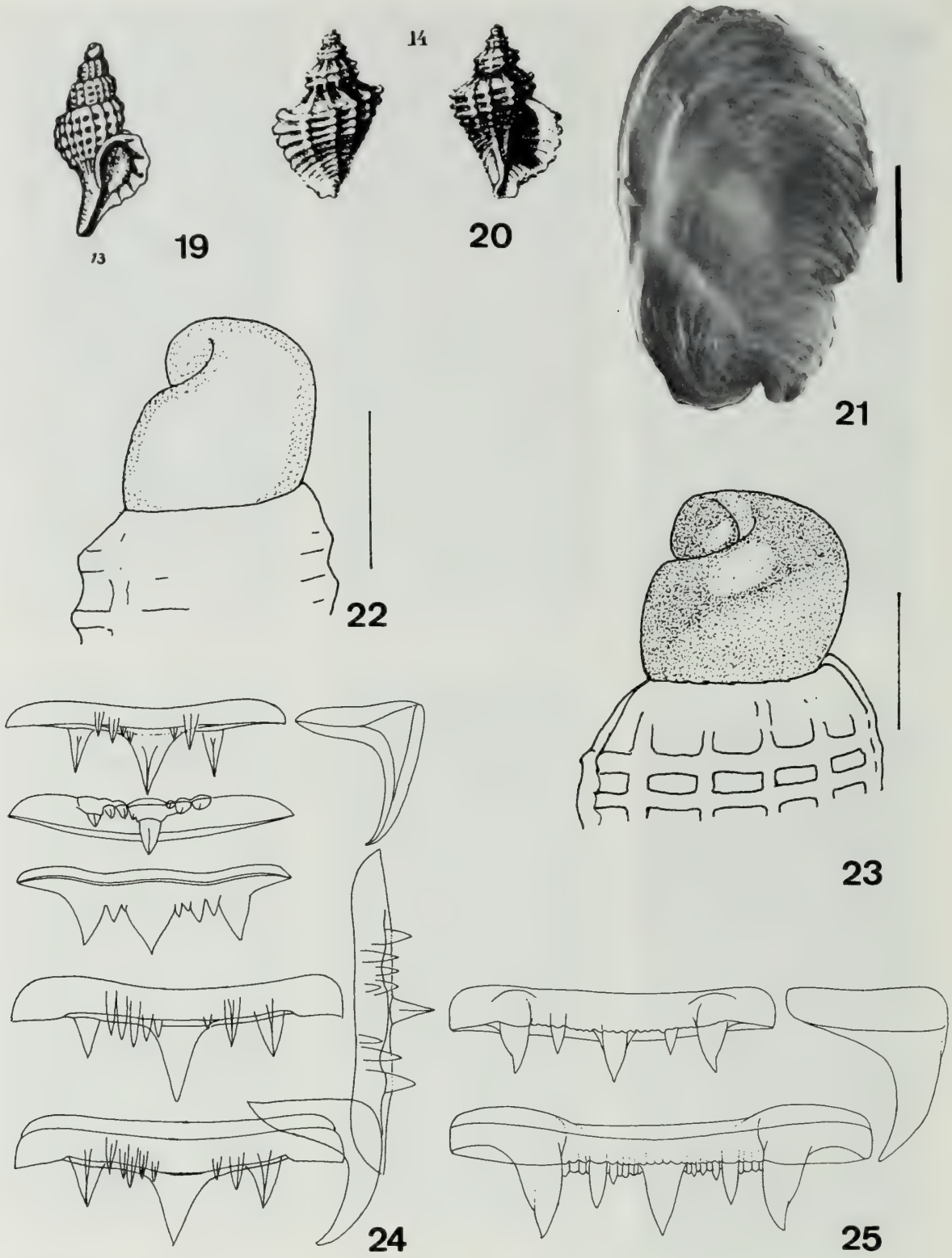
Figures 12-18

12. *Vaughtia scrobiculata* (Dunker, 1846), Haga Haga, South Africa, coll. RH, 12.8 mm.

13-14. *V. jucunda* (Thiele, 1925), Off Cape St Blaize, South Africa. 13. NM B853, 9.1 mm; 14. coll. RH, 10 mm.

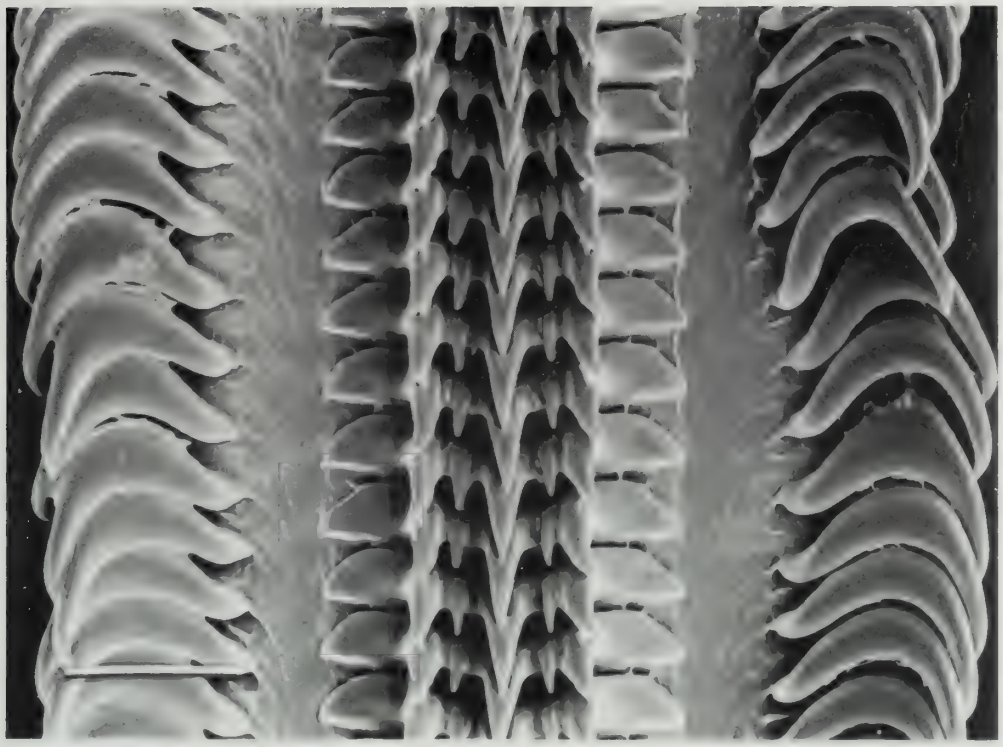
15. *V. fenestrata* (Gould, 1860), Jeffreys Bay (Kommetje), South Africa, coll. RH, 10.9 mm.

16-18. Detail of shoulder sculpture (scale bar: 2 mm). 16. *V. scrobiculata*; 17. *V. jucunda*; 18. *V. fenestrata*.



Figures 19-25

19. *Vaughtia jucunda* (Thiele, 1925), fig. 13, from THIELE (1925).
20. *Vaughtia dunkeri* (Krauss, 1848), fig. 14, from KRAUSS (1848).
21. Operculum of *V. dunkeri*, Hout Bay, South Africa (scale bar: 1 mm).
22. Protoconch of *V. babingtoni* (Sowerby, 1892) (scale bar: 0.5 mm).
23. Protoconch of *V. jucunda* (Thiele, 1925) (scale bar: 0.5 mm).
24. Different views of the radula of *Pterymarchia barclayanus* (H. Adams, 1873) (drawing A. D'Attilio).
25. Two views of the radula of *P. tripterus* (Born, 1778) (drawing A. D'Attilio).



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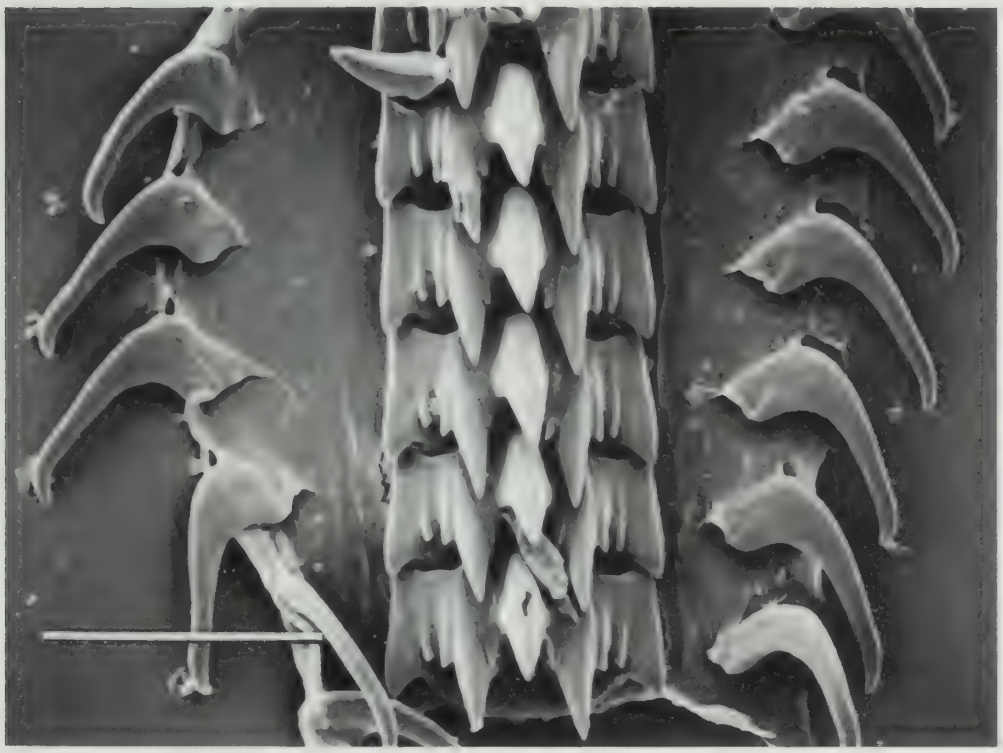

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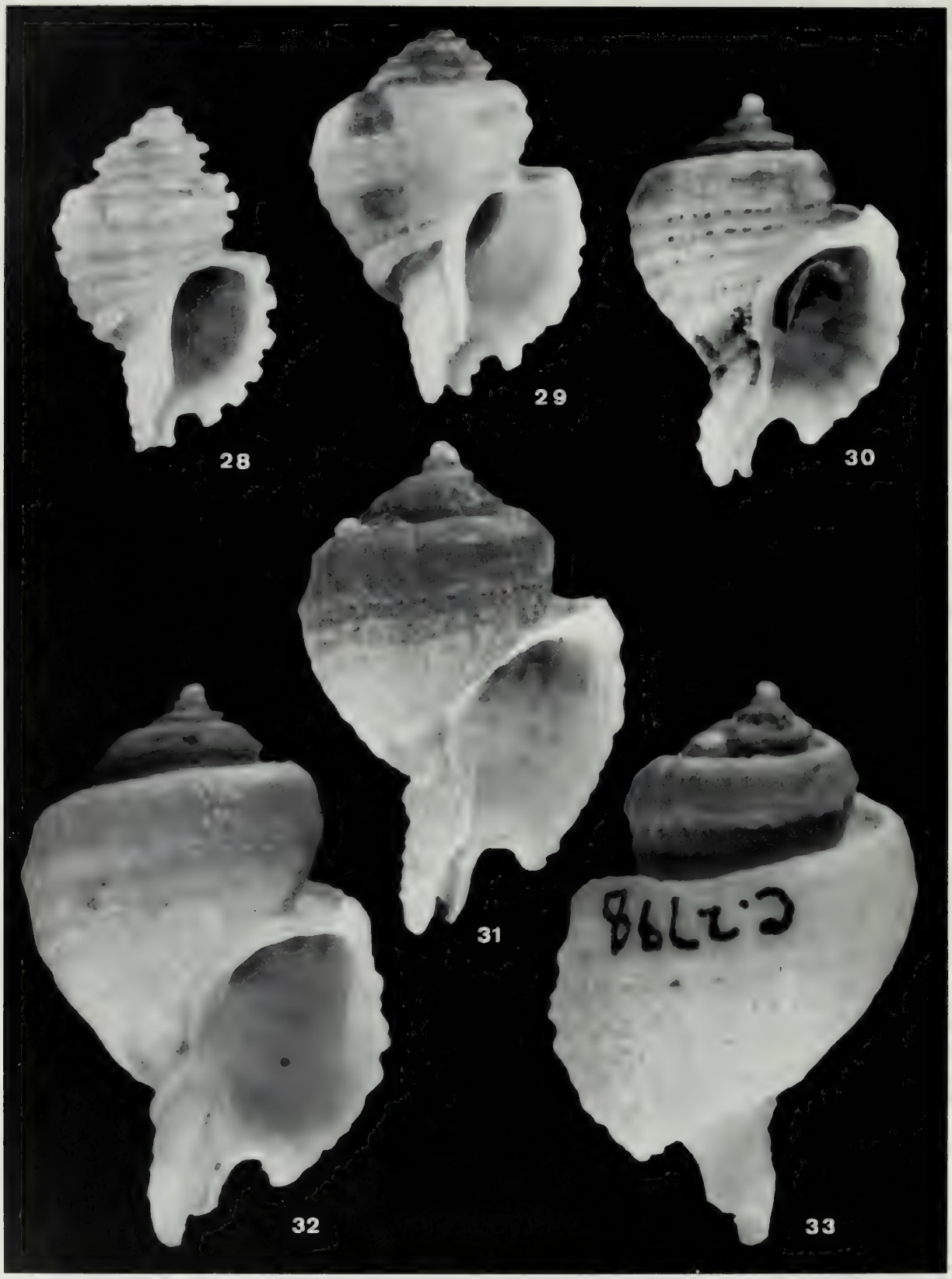
Figures 26-27 (radulae, scale bars: 50 µm)

26. Radula of *Pterymarchia bibbeyi* (Radwin & D'Attilio, 1976), Wakayama, Japan.

27. Radula of *Vaughtia dunkeri* (Krauss, 1848), Hout Bay, South Africa.



Figures 28-33 *Vaughtia scrobiculata* (Dunker, 1846), monstrosity.
28-29. Transkei, Xora, NM 6897, (28: 10.7 mm; 29: 11.4 mm).
30. Transkei, off Whale Rock, 31°56.9' S, 29°13.5' E, NM C7414, 8.6 mm.
31. Transkei, off Mncwasa Point, 32°05.5' S, 29°05.6' E, NM C2041, 10 mm.
32-33. Transkei, off Mncwasa Point, 32°05.3' S, 29°05.4' E, NM C2798, 12.8 mm.

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